Prepared for
Hawke's Bay Regional Council
Co No.: N/A

AECOM

Hawke's Bay Community Carbon Footprint

29-Nov-2022

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Hawke's Bay Community Carbon Footprint

Client: Hawke's Bay Regional Council

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Prepared by

AECOM New Zealand Limited
Level 19, 171 Featherston Street, Pōneke|Wellington 6011, PO Box 27277, Pōneke|Wellington 6141, New Zealand
T +64 4 896 6000 F +64 4 896 6001 www.aecom.com

29-Nov-2022

Job No.: 60671688

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 and ISO45001.

Quality Information

Document Hawke's Bay Community Carbon Footprint

Ref 60671688

Date 29-Nov-2022

Prepared by Adam Swithinbank and Tanya Milnes

Reviewed by Anthony Hume

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
1	27-Sept-2022	Final	Anthony Hume Team Leader - Sustainability	
2	13-Oct-2022	Final - includes updated infographics	Anthony Hume Team Leader - Sustainability	
3	29-Nov-2022	Final - includes updated infographic (Figure 1)	Anthony Hume Team Leader - Sustainability	

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Executive Summary

Greenhouse Gas (GHG) emissions for the Hawke's Bay Region (that is covered by the Hawke's Bay Regional Council) have been measured using the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory (GPC) methodology. This approach includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture and Forestry sectors. This document reports greenhouse gas emissions produced in or resulting from activity or consumption within the geographic boundaries of the Hawke's Bay Region for the 2020/21 financial reporting year and examines greenhouse gas emissions produced from 2018/19 to 2020/21.

The Hawke's Bay Region is referred to hereafter as Hawke's Bay for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

Major findings of the project include:

2020/21 Emissions Footprint

- In the 2020/21 reporting year (1st July 2020 to 30th June 2021), **total gross emissions** in Hawke's Bay were 4,345,997 tCO_2e.
- **Agriculture** (e.g., emissions from livestock and crops) is the largest source of emissions, accounting for 67% of the Hawke's Bay's total gross emissions, with enteric fermentation from livestock accounting for 78% of Agriculture emissions.
- **Transport** (e.g., emissions from road and air travel) is the second largest emitting sector in Hawke's Bay, representing 20% of total gross emissions, with petrol and diesel consumption accounting for 90% of Transport emissions.
- **Stationary Energy** (e.g., consumption of electricity and natural gas) is the third highest emitting sector in the region, producing 10% of total gross emissions.
- Net **Forestry** emissions were -2,862,841 in 2020/21 as carbon sequestration (carbon captured and stored in plants or soil by forests) was higher than emissions from forest harvesting (e.g., the release of carbon from roots and organic matter following harvesting). Net **Forestry** emissions are not included in total gross emissions.
- The **total net emissions** in Hawke's Bay were 1,483,156 tCO_2e. The total net emissions include emissions and sequestration from forestry.

Changes in Emissions, 2018/19 to 2020/21

- Between 2018/19 and 2020/21, **total gross emissions** in Hawke's Bay decreased from 4,497,263 tCO_2e to 4,345,997 tCO_2e, a decrease of 3% (151,267 tCO_2e).
- Over this time the population of the Region increased by 4%, resulting in **per capita gross emissions** in Hawke's Bay decreasing by 7% between 2018/19 and 2020/21, from 25.9 to 24.1 tCO_2e per person per year.
- Emissions from **Stationary Energy** increased by 20% between 2018/19 and 2020/21 (69,806 tCO_2e), driven by a 45% increase in electricity consumption emissions (56,198 tCO_2e). This increase in electricity consumption emissions was due to a 4% increase in electricity consumption (kWh) coupled with a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh).
- Emissions from **Agriculture** decreased by 8%, between 2018/19 and 2020/21 (245,553 tCO_2e), due to a reduction in livestock numbers, particularly of sheep and non-dairy cattle.
- **Transport** and **Waste** emissions both increased by 3% (21,822 tCO_2e and 2,491 tCO_2e respectively).

- Emissions from forest harvesting reduced by 3% (118,442 tCO_2e), while sequestration from forestry increased by 2% (102,706 tCO_2e) resulting in the net impact of **Forestry** changing by 8% from -2,641,693 tCO_2e to -2,862,841tCO_2e.

Figure 1: Hawke's Bay 2020/21 Emissions Footprint

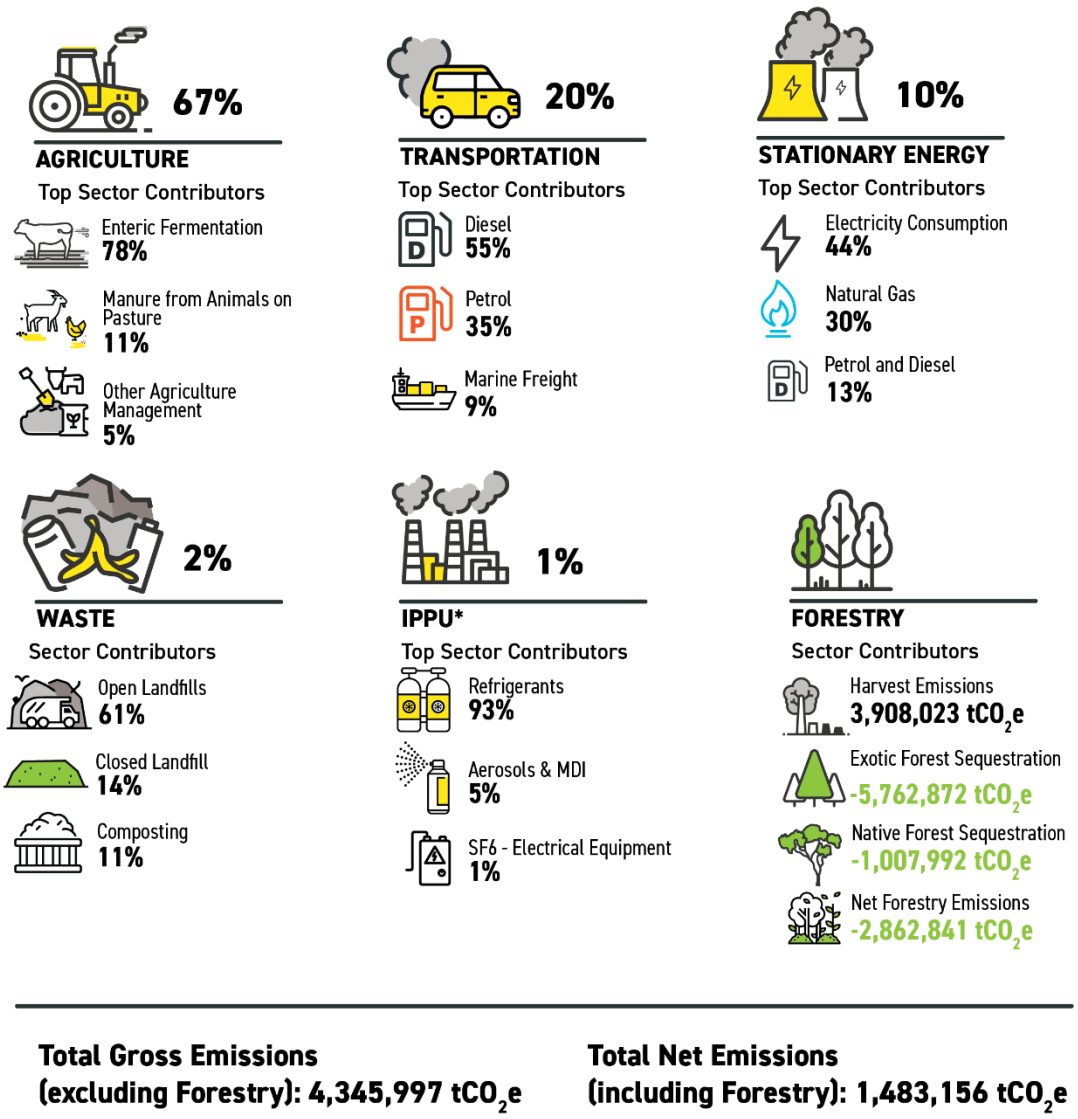
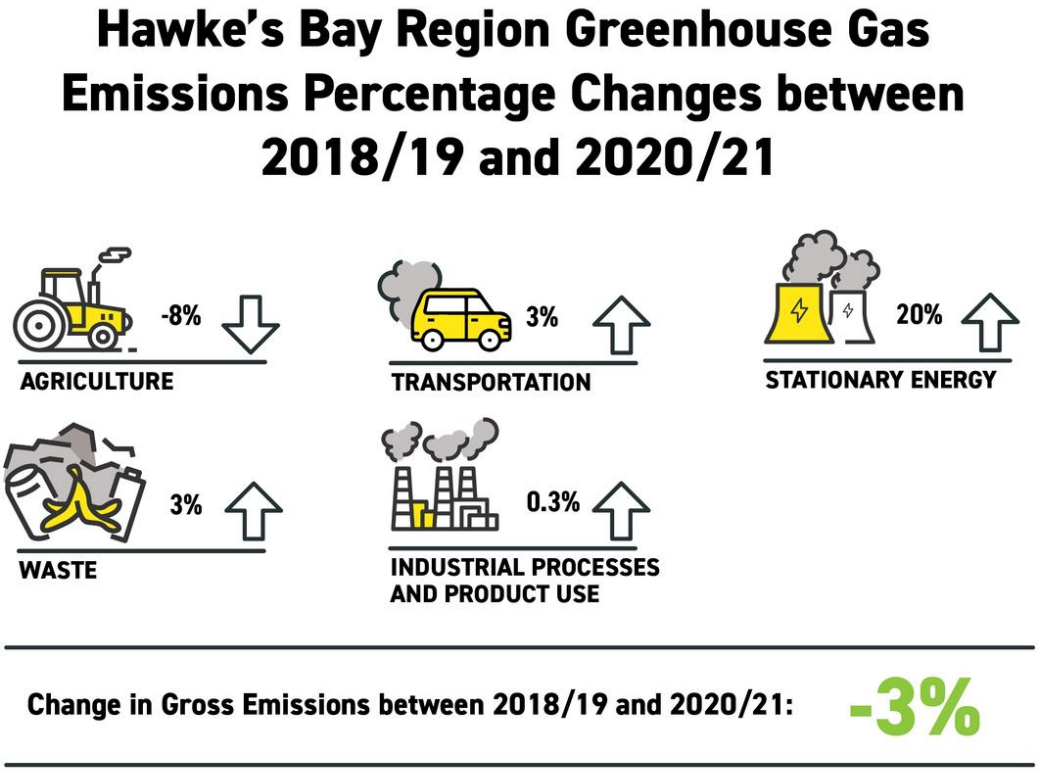


Figure 2: Change in Hawke's Bay Emissions Footprint between 2018/19 and 2020/21



1.0 Introduction

AECOM New Zealand Limited (AECOM) was commissioned by the Hawke's Bay Regional Council to assist in the development of community-scale greenhouse gas (GHG) footprints for the Hawke's Bay for the 2018/19, 2019/20, and 2020/21 financial years. This is part of a wider study to develop community carbon footprints for each district within the Hawke's Bay region. Emissions are reported for the period from 1 July to 30 June for the respective years. The study boundary reported in the following pages incorporates the jurisdiction of the Hawke's Bay Regional Council.

The Hawke's Bay region is referred to hereafter as Hawke's Bay for ease. Greenhouse gas emissions are generally reported in this document in units of Carbon Dioxide Equivalents (CO_2e) and are referred to as 'emissions'.

2.0 Approach and Limitations

The methodological approach used to calculate emissions follows the Global Protocol for Community Scale Greenhouse Gas Emissions Inventory v1.1 (GPC) published by the World Resources Institute (WRI) 2021. The GPC includes emissions from Stationary Energy, Transport, Waste, Industrial Processes and Product Use (IPPU), Agriculture, and Forestry activities within the Region's boundary. The sector calculations for Agriculture, Forestry and Waste are based on Intergovernmental Panel on Climate Change (IPCC) workbooks and guidance for emissions measurement. The sector calculators also use methods consistent with GHG Protocol standards published by the WRI for emissions measurement when needed.

The same methodology has been used for other community scale GHG footprints around New Zealand, (e.g., Wellington, Auckland, Christchurch, Dunedin, and the Waikato region) and internationally. The GPC methodology[1] represents international best practice for city and regional level GHG emissions reporting.

This emissions footprint assesses both direct and indirect emissions sources. Direct emissions are production-based and occur within the geographic area (Scope 1 in the GPC reporting framework). Indirect emissions are produced outside the geographic boundary (Scope 2 and 3) but are allocated to the location of consumption. An example of indirect emissions is those associated with the consumption of electricity, which is supplied by the national grid (Scope 2). All other indirect emissions such as cross-boundary travel (e.g. flights) and energy transportation and distribution losses fit into Scope 3.

All major assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**. The following aspects are worth noting in reviewing the emissions footprint:

- Emissions are expressed on a carbon dioxide-equivalent basis (CO_2e) including climate change feedback using the 100-year Global Warming Potential (GWP) values[2]. Climate change feedbacks are the climate change impacts from GHGs that are increased as the climate changes. For example, once the Earth begins to warm, it triggers other processes on the surface and in the atmosphere. Current climate change feedback guidance is important to estimate the long-term impacts of GHGs.
- GPC reporting is predominately production-based (as opposed to consumption-based) but includes some elements of consumption-based footprinting (e.g. indirect emissions from electricity consumption). Production-based emissions reporting is generally preferred by policy-makers due to robust established methodologies such as the GPC, which enables comparisons between different studies. Production-based approaches exclude globally produced emissions relating to consumption (e.g. embodied emissions relating to products produced elsewhere but consumed within the geographic area such as imported food products, cars, phones, clothes etc.).
- Total emissions are reported as both gross emissions (excluding Forestry) and net emissions (including Forestry).

[1] http://www.ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities
[2] https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf (Table 8.7)

- Emissions for individual main greenhouse gases for each emissions source are provided in the supplementary spreadsheet information supplied with this report.
- Where location specific data were not accessible, information was calculated based on national or regional level data.
- Transport emissions:
  - Transport emissions associated with air travel, rail, and marine fuel were calculated by working out the emissions relating to each journey arriving or departing the area based on data provided by the relevant operators. Emissions for these sources are then split equally between the destination and origin. Emissions relating to a particular point source (e.g. an airport or port) are allocated to the expected users of that source, not just the area that it is located in. For example, in the Hawke's Bay Region, it is expected that all territorial authorities will use the Port of Napier for imported and exported goods, so emissions from this source have been allocated to all territorial authorities in the region based on population. It is understood that freight imports moving through the Port of Napier do not exclusively serve the Hawke's Bay Region, and freight exports do not exclusively originate from the Hawke's Bay Region, this should be considered when examining these emissions.
  - All other transport emissions are calculated using the fuel sold in the area (e.g. petrol, diesel, LPG).
- Solid waste emissions:
  - Solid waste emissions from landfill are measured using the IPCC First Order Decay method that covers landfill activity between 1950 and the present day.
  - Emissions are calculated for waste produced within the geographic boundary, even if they are transported outside the boundary to be entered into landfill.
  - An additional assessment of transport emissions related to the transport of landfill waste and recycled/diverted waste has been included in this assessment, outside of the GPC requirements for Community Carbon Footprints. Emissions were estimated based on the amount of material, distance transported from transfer station to next processing location, and the vehicles used. Any onward transport of materials post-processing have not been included.
- Wastewater emissions:
  - Emissions have been calculated based on the local data provided, following IPCC 2019 guidelines. Where data is missing, IPCC and Ministry for the Environment (MfE) figures have been used. Wastewater emissions from both wastewater treatment plants, and individual septic tanks have been calculated.
  - Wastewater emissions include those released directly from wastewater treatment, flaring of captured gas, and from discharge onto land/water.
- Industrial Processes and Product Use (IPPU) emissions:
  - IPPU emissions are estimated based on data provided in the New Zealand Greenhouse Gas Emissions 1990-2020 report (MfE 2022). Emissions are estimated on a per capita basis applying a national average per person.
- Forestry emissions:
  - This emissions footprint accounts for forest carbon stock changes from afforestation, reforestation, deforestation, and forest management (i.e. it applies land-use accounting conventions under the United Nations Framework Convention on Climate Change rather than the Kyoto Protocol). It treats emissions from harvesting and deforestation as instantaneous rather than accounting for the longer-term emission flows associated with harvested wood products.
  - The emissions footprint considers regenerating (growing) forest areas only. Capture of carbon from the atmosphere is negligible for mature forests that have reached a steady state.

Overall sector data and results for the emissions footprint have been provided to the Hawke's Bay Regional Council in calculation table spreadsheets. All assumptions made during data collection and analysis have been detailed within **Appendix A – Assumptions**.

It is important to consider the level of uncertainty associated with the results, particularly given the different datasets used. Depending on data availability, national, regional, and local datasets are used across the different calculators. At the national level, New Zealand's Greenhouse Gas Inventory shows that for 2018 (the most recent national level inventory) an estimate of gross emissions uncertainty was +/- 9%, whereas a net emissions uncertainty estimate was +/- 12%. These levels of uncertainty should be considered when interpreting the results of this community carbon footprint (MfE, 2020).

StatsNZ Regional Footprint

Due to differences in emission factors and methodology used between the StatsNZ Regional Footprints and this community carbon footprint (based on the GPC requirements and available data), caution should be taken when making comparison of reported emissions. One example of this is where this footprint used updated emission factors for methane and nitrous oxide following guidance from the IPCC and in line with other Region and regional level GHG inventories in New Zealand. This difference is especially relevant for the Agriculture and Transport sectors.

Differences between the StatsNZ Regional Footprints and this community carbon footprint may be due to scope, coverage, data sources, and methods. The StatsNZ Regional Footprint approach is based on production, while the GPC methodology includes elements of consumption. The Stats NZ Regional Footprints use a residence approach, while GPC is based on the territory approach. The Stats NZ Regional Footprints also use global warming potentials from the IPCC Fourth Assessment Report, whilst this community carbon footprint uses global warming potentials from the IPCC Fifth Assessment Report.

Refer to the StatsNZ website for further information regarding StatsNZ Regional Footprint https://www.stats.govt.nz/methods/about-regional-greenhouse-gas-emissions-statistics/.

3.0 Community Carbon Footprint for 2020/21

The paragraphs, figures and tables below outline the Hawke's Bay's greenhouse gas emissions, referred to as 'emissions' in this assessment. This includes The Hawke's Bay's total emissions, emissions from each sector, and major emissions sources within each sector. The focus of emissions reporting is on gross emissions.

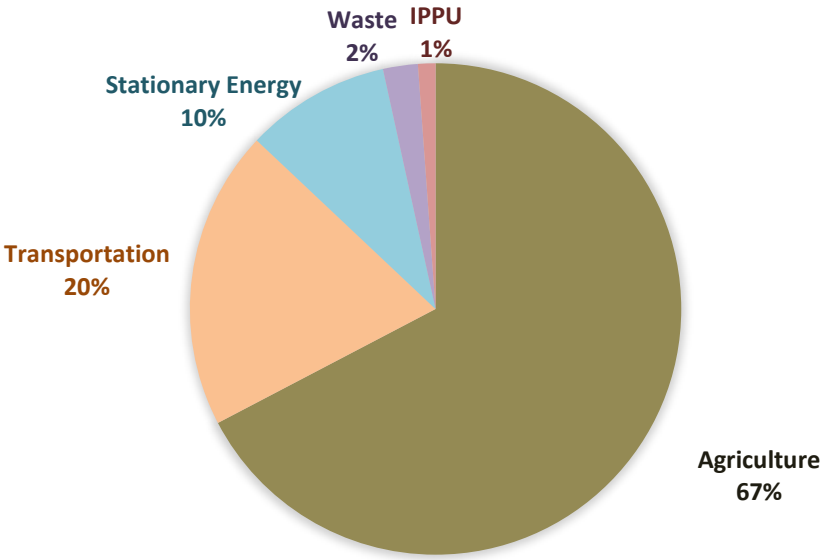
During the 2020/21 reporting period, Hawke's Bay emitted **gross** 4,345,997 tCO_2e. Note that gross emissions do not account for Forestry. Agriculture and Transport emissions are the largest contributors to total gross emissions for the Region.

The population of Hawke's Bay in 2020/21 was approximately 180,610 people, resulting in per capita gross emissions of 24.1 tCO_2e/person. Discussion of per capita emissions is limited to when it is useful for comparing emission figures against other territorial authorities. A breakdown of net emissions (i.e. including results from Forestry resources) is reported separately.

Table 1 Total net and gross emissions

Total emissions	tCO_2e
Total Net Emissions (including forestry)	1,483,156
Total Gross emissions (excluding forestry)	4,345,997

Figure 3: Hawke's Bay Region's total gross GHG emissions split by sector (tCO_2e).



During the 2020/21 reporting period, Hawke's Bay emitted **net** 1,483,156 tCO_2e.

Net emissions differ from gross emissions because they include emissions related to forestry activity (harvesting and planting) within an area. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes. In addition, with each subsequent planting of harvestable trees, there is a decreasing ebb and flow of sequestration.

Carbon sequestered by forestry can be viewed as a liability/risk that needs careful consideration. For example, if plantations are not replanted or other land use change occurs to exotic forested areas, then net emissions may rise quickly. Equally, if native forest is not protected from removal, and removal does happen, then net emissions may rise.

The community carbon footprint comprises emissions from six different sectors, summarised below:

3.1 Agriculture

The highest emitting sector in Hawke's Bay, Agriculture, emitted 2,925,915 tCO_2e in 2020/21. Table 2 provides the emissions, percentage of total gross emissions, and percentage of the sector total for each sector/emissions source. Agricultural emissions are the result of both livestock and crop farming and do not include emissions relating to fuel or electricity consumption (reported in the Transport and Stationary Energy sectors).

Enteric fermentation from livestock produced 78% of Hawke's Bay's Agricultural emissions (2,274,432 tCO_2e). Enteric fermentation GHG emissions are produced by methane (CH_4) released from the digestive process of ruminant animals (e.g. cattle and sheep). The second largest source of agricultural emissions was produced from nitrous oxide (N_2O) released by unmanaged manure from grazing animals on pasture (332,570 tCO_2e or 11% of the Agricultural sector's emissions).

Table 2 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Enteric Fermentation	2,274,432	52.3%	77.7%
Manure from Grazing Animals on pasture	332,570	7.7%	11.4%
Other Agriculture Emissions	132,079	3.0%	4.5%
Atmospheric Deposition	93,329	2.1%	3.2%
Manure Management	47,822	1.1%	1.6%
Agricultural Soils	22,614	0.5%	0.8%
Fertiliser used in Horticulture	23,070	0.5%	0.8%
Total	**2,925,915**	**67%**	**100%**

Livestock were responsible for 96% of the Agriculture sector's GHG emissions (1,796,732 tCO_2e) (Table 3). Sheep account for 49% of agricultural emissions in the Hawke's Bay and 33% of the Hawke's Bay's total gross emissions. Non-dairy cattle account for 37% of agricultural emissions in the Hawke's Bay and 25% of the Hawke's Bay's total gross emissions.

Table 3 Agriculture emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Sheep	1,427,404	33%	49%
Non-dairy Cattle	1,072,780	25%	37%
Dairy Cattle	293,306	7%	10%
Other livestock	65,709	2%	2%
Fertiliser (other)	43,646	1%	1%
Fertiliser for Horticulture	23,070	1%	0.8%
Total	**2,925,915**	**67%**	**100%**

Fertilisers used for livestock and horticulture represent 4% of Agriculture emissions. An additional breakdown of emissions from fertiliser use in horticulture is included based on land-use information provided by HBRC covering the Hastings and Napier area only. Fertiliser use in horticulture represented 0.8% of the sector emissions. The largest contributor to 'Fertiliser for Horticulture' emissions in Hastings was sweetcorn (12,643 tCO_2e, 1.1% of Agricultural emissions) (displayed in Table 4). There is some

potential for emissions double counting between the 'Fertiliser for Horticulture' and 'Fertiliser (other)' as these emissions have been calculated based on different datasets, where the 'Fertiliser (other)' category may also include some fertilisers used in horticulture. However, it is expected that the majority of the 'Fertiliser (other)' emissions are caused by fertiliser use for livestock land. Changes in soil carbon associated with horticulture have not been quantified due to absence of a defined appropriate method for assessing the carbon footprint associated with soil carbon change over time.

Table 4 Fertiliser for horticulture emissions by crop type

Sector / Emissions Source	tCO_2e	Hectares (Ha)
Sweetcorn	12,643	4,026
Pipfruit	2,380	4,829
Squash	2,188	1,736
Peas and Beans	1,479	2,791
Stonefruit	1,230	2,495
Beetroot	983	1,854
Grapes	910	5,351
Onions	839	482
Wheat	196	248
Kiwifruit	146	216
Grain	69	88
Tomato	7	82
Total	**23,070**	**24,197**

3.2 Transport

Transport, the second highest emitting sector in Hawke's Bay, produced 856,520 tCO_2e in 2020/21 (20% of the Hawke's Bay's gross total emissions). Table 5 provides the total emissions, percentage of the total gross emissions, and percentage of the sector total for each sector/emissions source.

Table 5 Transport emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Diesel	472,063	10.9%	55.1%
Petrol	300,868	6.9%	35.1%
Marine Freight	78,488	1.8%	9.2%
Jet Kerosene	2,635	0.1%	0.3%
LPG	1,546	<0.1%	0.2%
Rail	647	<0.0%	0.1%
Aviation Gas	272	<0.1%	<0.1%
Total	**856,520**	**20%**	**100%**

Most of the transport emissions can be attributed to on and off-road diesel and petrol use, which collectively produced 90% of the sector's emissions and 18% of total gross emissions. Diesel and petrol transport emissions are broken down into on-road and off-road use. On-road transport consists of all standard transportation vehicles used on roads (including cars, trucks, buses, etc.). Off-road transport consists of all fuel used for the movement of machinery and vehicles off roads (including agricultural

tractors and vehicles, forklifts, etc.). On-road transport produced 681,394 tCO_2e (80% of Transport emissions). Off-road transport produced 93,084 tCO_2e (11% of Transport emissions).

The next largest Transport emission source is marine freight, which contributed to 9% of the sectors emissions and 2% of Hawke's Bay's total gross emissions (74,488 tCO_2e). Marine freight emissions are the result of freight movements to and from the Port of Napier. Emissions from this source have been divided between all territorial authorities in the Hawke's Bay region based on relative population sizes. It is understood that the imports and exports through this port are not exclusively related to activities in the Hawke's Bay region, however, to ensure that these emissions are reflected in community carbon footprints as per the GPC requirements this approach is appropriate.

The remaining transport emissions are attributed to air travel (jet kerosene and aviation gas), rail freight emissions and LPG use for transport (e.g. forklifts).

3.3 Stationary Energy

Producing 414,152 tCO_2e in 2020/21, Stationary Energy was The Hawke's Bay's third highest emitting sector (10% of total gross emissions). Table 6 provides the total emissions, percentage of total gross emissions, and percentage of the sector total for each sector/emissions source.

Electricity consumption was the cause of 44% of Stationary Energy emissions (181,396 tCO_2e), and 4% of The Hawke's Bay's total gross emissions. Electricity consumption emissions increase to 198,058 tCO_2e when including transmission and distribution losses related to that consumption.

Natural gas consumption accounted for 33% of the sector's emissions (135,607 tCO_2e) when including transmission and distribution losses. Stationary petrol and diesel consumption generated 13% of the sectors emissions (52,339 tCO_2e). Use of LPG, and the burning of coal, biofuels and biogas produced the remaining Stationary Energy emissions.

Table 6 Stationary Energy emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Electricity Consumption	181,396	4.2%	43.8%
Natural Gas	125,465	2.9%	30.3%
Stationary Petrol & Diesel Use	52,339	1.2%	12.6%
Electricity Transmission and Distribution Losses	16,663	0.4%	4.0%
LPG	12,261	0.3%	3.0%
Coal	10,343	0.2%	2.5%
Natural Gas Transmission and Distribution losses	10,143	0.2%	2.4%
Biofuel / Wood	5,447	0.1%	1.3%
Biogas	96	<0.1%	<0.1%
Total:	**414,152**	**10%**	**100%**

Stationary Energy demand can also be broken down by the sector in which it is consumed. Stationary Energy demand is reported for the following sectors: commercial; residential and industrial.

- Industrial Stationary Energy consumption accounts for 51% of Stationary Energy emissions (209,500 tCO_2e) and 5% of total gross emissions. Industrial Stationary Energy is energy used

within all industrial settings (including agriculture, forestry and fishing, mining, food processing, textiles, chemicals, metals, mechanical/electrical equipment and building and construction activities).

- Residential Stationary Energy consumption accounts for 20% of Stationary Energy emissions (82,378 tCO_2e) and 2% of total gross emissions. Residential Stationary Energy is energy used in homes (e.g. for heating, lighting, and cooking).
- Commercial Stationary Energy consumption accounts for 17% of Stationary Energy emissions (69,839 tCO_2e) and 2% of total gross emissions. Commercial Stationary Energy is energy used in all non-residential and non-industrial settings (e.g. in retail, hospitality, education, and healthcare).
- The remaining 13% of Stationary Energy emissions (52,435 tCO_2e, 1% of gross emissions) were produced by diesel and petrol, and the burning of biogas, which were not allocated to the above categories. Stationary Energy uses of diesel and petrol include stationary generators and motors and for heating.

3.4 Waste

Waste originating in Hawke's Bay (solid waste and wastewater) produced 99,459 tCO_2e in 2020/21, which comprises 2% of Hawke's Bay's total gross emissions. Table 7 provides the total emissions, percentage of total gross emissions, and percentage of the sector total for each sector/emissions source.

Table 7 Waste emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Waste in open landfill sites	60,295	1.4%	60.6%
Waste in closed landfill sites	13,743	0.3%	13.8%
Composting	11,125	0.3%	11.2%
Wastewater treatment plants	7,673	0.2%	7.7%
Individual septic tanks	6,623	0.2%	6.7%
Total:	**99,459**	**2%**	**100%**

Solid waste produced the bulk of Waste emissions (74,038 tCO_2e), making up 74% of total Waste emissions. Solid waste emissions include emissions from open landfills and closed landfills. Both open and closed landfills emit methane from the breakdown of organic materials disposed of in the landfill for many years after waste enters the landfill. Waste from Hawke's Bay sent to open landfill sites contributed 60,295 tCO_2e. Emissions from closed landfill sites produced 13,743 tCO_2e. Annual emissions from closed landfill sites will decrease over time as no new waste enters these sites.

Wastewater treatment (treatment plants and individual septic tanks) produced 14,296 tCO_2e making up 14% of total Waste emissions. Most of the households in Hawke's Bay are connected to wastewater treatments plants, which produced total emissions of 7,673 tCO_2e. Due to the production of methane, septic tanks have a higher emissions intensity compared to the wastewater treatments plants in Hawke's Bay. Households connected to individual septic tanks produced 6,623 tCO_2e in wastewater emissions.

Wastewater treatment tends to be a relatively small emission source compared to solid waste as advanced treatment of wastewater produces low emissions. In contrast, solid waste generates methane gas over many years as organic material enters landfill.

Composing produced 11,125 tCO_2e making up 11% of total Waste emissions. Waste diverted from landfill for composting in the Hawke's Bay Region includes horticultural, animal waste products, green waste, bark and sawdust.

3.5 Industrial Processes and Product Use (IPPU)

IPPU in Hawke's Bay produced 49,950 tCO_2e in 2020/21, contributing 1% to Hawke's Bay's total gross emissions. This sector includes emissions associated with the production of GHGs for refrigerants, foam blowing, fire extinguishers, aerosols, metered dose inhalers and Sulphur Hexafluoride for electrical insulation and equipment production. IPPU emissions do not include energy use for industrial manufacturing, which is included in the relevant Stationary Energy sub-category (e.g. coal, electricity and/or petrol and diesel). These emissions are based on nationally reported IPPU emissions and apportioned based on population due to the difficulty of allocating emissions to particular geographic locations.

There are no known industrial processes (as defined in the GPC requirements) present in the Hawke's Bay (e.g. aluminium manufacture).

Table 8 provides the total emissions, percentage of total gross emissions, and percentage of the sector's total for each sector/emissions source. The most significant contributor to IPPU emissions is the use of refrigerants which produced 93% of IPPU emissions (46,441 tCO_2e).

Table 8 Industrial processes and product use emissions by emission source

Sector / Emissions Source	tCO_2e	% of Total Gross Emissions	% of Sector Total
Refrigerants and air conditioning	46,441	1.1%	93.0%
Aerosols	2,601	0.1%	5.2%
SF6 - Electrical Equipment	508	<0.1%	1.0%
Foam Blowing	220	<0.1%	0.4%
SF6 - Other	100	<0.1%	0.2%
Fire extinguishers	80	<0.1%	0.2%
Total	**49,950**	**1.0%**	**100%**

3.6 Forestry

Planting of native forest (e.g. mānuka and kānuka) and exotic forest (e.g. pine), sequesters (captures) carbon from the atmosphere while the trees are growing to maturity. Harvesting of forest releases emissions via the release of carbon from organic matter and soils following harvesting. When sequestration by forests exceeds emissions from harvesting, the extra quantity of carbon sequestered by forest reduces net Forestry emissions. Conversely when emissions from harvesting exceed the amount of carbon sequestered by native and exotic forests, then net Forestry emissions will increase.

Sequestration in 2020/21 was 6,770,864 tCO_2e (which was mostly from exotic forests) while harvesting emissions were 3,908,023 tCO_2e. This meant that Forestry in Hawke's Bay was a net negative source of emissions in 2020/21 (rather than a positive source of emissions, where harvesting exceeds sequestration). Total Forestry emissions in 2020/21 were -2,862,841 tCO_2e. It is noted that harvesting of exotic forest can be cyclical in nature where some years will have higher sequestration and some years will have higher harvesting emissions determined by age of forests, commercial operators, and the global market.

Table 9 Forestry emissions by emission source (including sequestration)

Sector / Emissions Source	tCO_2e
Total harvest emissions	3,908,023
Native forest sequestration	-1,007,992
Exotic forest sequestration	-5,762,872
Total	**-2,862,841**

3.7 Total Gross Emissions by Greenhouse Gas

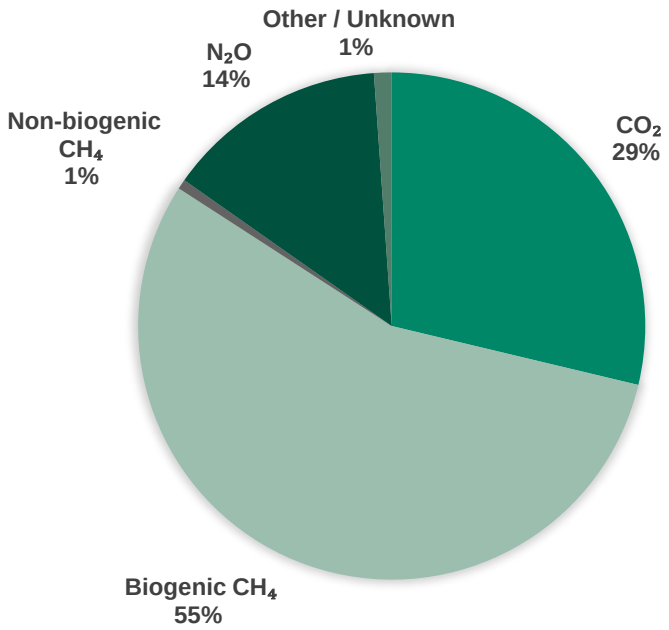
Each greenhouse gas has a different level of impact on climate change, this is accounted for when converting quantities of each gas into units of carbon dioxide equivalent (CO_2e).

Table 10: Hawke's Bay's total gross emissions, by greenhouse gas

Greenhouse Gas	Tonnes	Tonnes of CO_2e
Carbon Dioxide (CO_2)	1,248,710	1,248,710
Biogenic Methane (CH_4)	70,814	2,407,693
Non-biogenic Methane (CH_4)	795	27,030
Nitrous Oxide (N_2O)	2,060	613,673
Other / Unknown Gas (in CO_2e)	48,891	48,891
Total	**1,369,680**	**4,345,997**

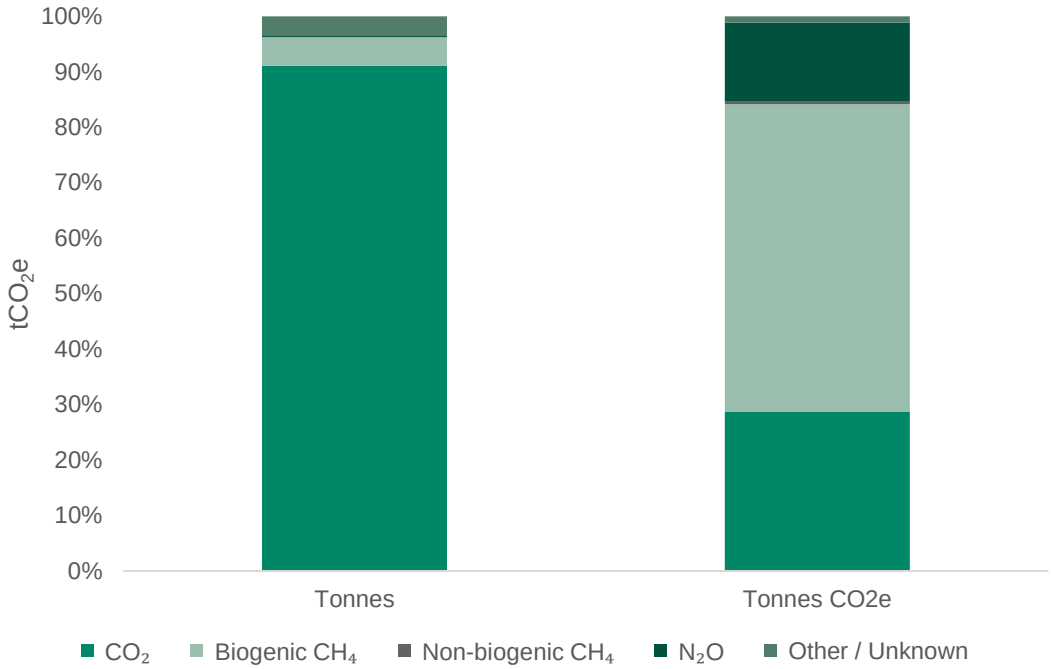
Figure 4 illustrates the Hawke's Bay's total gross emissions by greenhouse gas in units of carbon dioxide equivalents (CO_2e).

Figure 4: The Hawke's Bay Region's total gross emissions, by greenhouse gas (in tCO_2e)



Due to the greater global warming impact of methane, methane represents just 5% of the total tonnage of GHG emissions from the Hawke's Bay but represents 55% of CO_2e. Nitrous oxide represents 0.2% of the total tonnage of GHG emissions from Hawke's Bay but represents 14% of CO_2e. This effect can be seen in Figure 5.

Figure 5: Hawke's Bay Region's total gross emissions, by greenhouse gas in tonnes and in tonnes of CO_2e



3.8 Biogenic emissions

Biogenic carbon dioxide and methane emissions are stated in Table 11 and Table 12, respectively.

Biogenic CO_2 emissions are those that result from the combustion of biomass materials that store and sequester CO_2, including materials used to make biofuels (e.g. trees, crops, vegetable oils, or animal fats). Biogenic CO_2 emissions from plants and animals are excluded from gross and net emissions as they are part of the natural carbon cycle.

Table 11: Biogenic CO_2 in the Hawke's Bay (Excluded from gross emissions)

Biogenic Carbon Dioxide (CO_2) (Excluded from gross emissions)		
Biofuel	178,324	t CO_2
Combusted Landfill Gas	14,793	t CO_2
Total Biogenic CO_2	**193,117**	**t CO_2**

Biogenic CH_4 emissions (e.g., produced by farmed cattle via enteric fermentation) are included in gross emissions due to their relatively large impact on global warming relative to biogenic CO_2. Biogenic methane represents 5% of the gross total tonnage of GHG emissions in the Hawke's Bay but represents 55% of total gross GHG emissions when expressed in CO_2e. This is caused by the higher global warming impact of methane per tonne, compared to carbon dioxide. The total tonnage of each GHG and the contribution of each GHG to total gross emissions when expressed in CO_2e is shown in Table 10.

The importance of biogenic CH_4 is highlighted in NZ's Climate Change Response (Zero Carbon) Amendment Act. The Act includes specific targets to reduce biogenic CH_4 by between 24% and 47% below 2017 levels by 2050, and by 10% below 2017 levels by 2030. More information on the Act is available here: https://www.mfe.govt.nz/climate-change/zero-carbon-amendment-act.

Table 12: Biogenic Methane in the Hawke's Bay (Included in gross emissions)

Biogenic Methane (CH_4) (Included in gross emissions)		
Enteric Fermentation	66,895	t CH_4
Landfill Gas	2,177	t CH_4
Manure Management	1,407	t CH_4
Wastewater Treatment	404	t CH_4
Composting (Green Waste)	190	t CH_4
Biofuel	143	t CH_4
Total Biogenic CH_4	**71,217**	**t CH_4**

3.9 Territorial Authorities in the Hawke's Bay Region

The Hawke's Bay regional area contains several territorial authorities. Hastings District, Napier City, Central Hawkes Bay District, and Wairoa District are all exclusively within the boundaries of the Hawke's Bay region. Additionally, areas of Taupō District and Rangitīkei District are also part of the Hawke's Bay region. We estimate that 0.1% of Taupō's population and 12% of Taupō's area, and 0.3% of Rangitīkei's population and 14% of Rangitīkei's area are within the Hawke's Bay region.

Figure 6 shows the Hawke's Bay's total gross emissions divided by territorial authority. Figure 7 shows total gross emissions for the territorial authorities in the Hawke's Bay Region, split by sector. Both figures only include the emissions produced within the Hawke's Bay region for Taupō and Rangitīkei.

Hastings is the highest emitting territorial authority in the region, representing 43% of the Hawke's Bay's total gross emissions. Hastings' emissions inventory is predominantly agriculture-related emissions with the next largest emitting territorial authorities; Central Hawke's Bay and Wairoa, also containing significant agricultural emissions. Of the four territorial authorities entirely within the Hawke's Bay region, Napier has the lowest total gross emissions, with emissions mostly from Transport and Stationary Energy. The areas of Taupō and Rangitīkei contribute to 2% of the Hawke's Bay region's total gross emissions, almost entirely from Agriculture.

Figure 6 Hawke's Bay's total gross emissions divided by territorial authority (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.

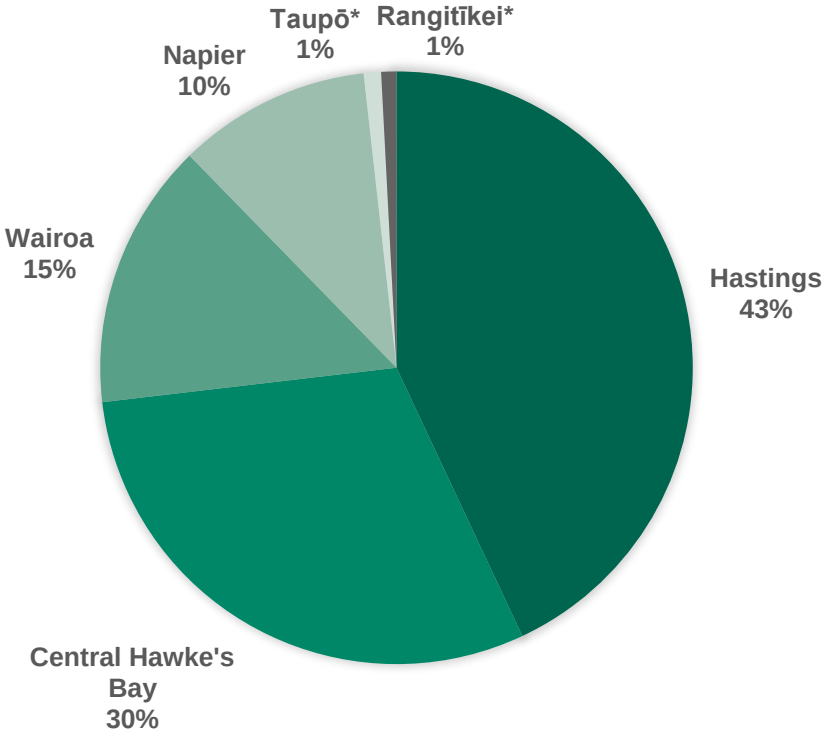
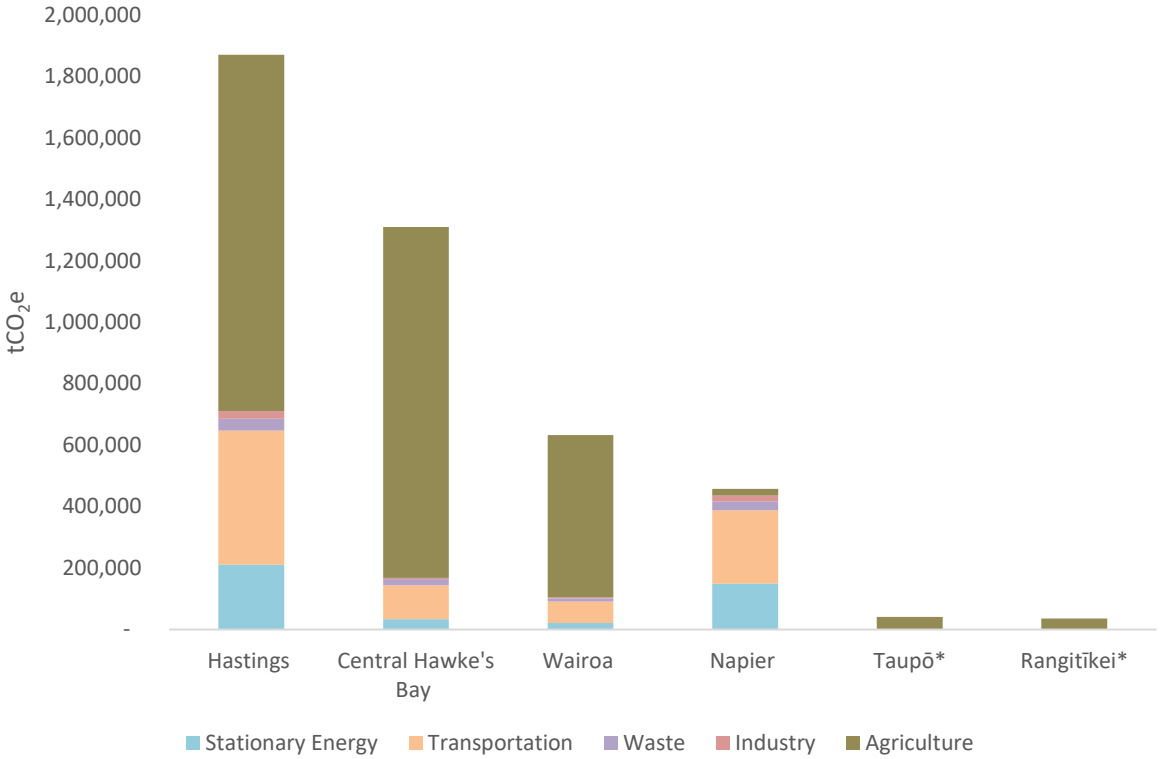


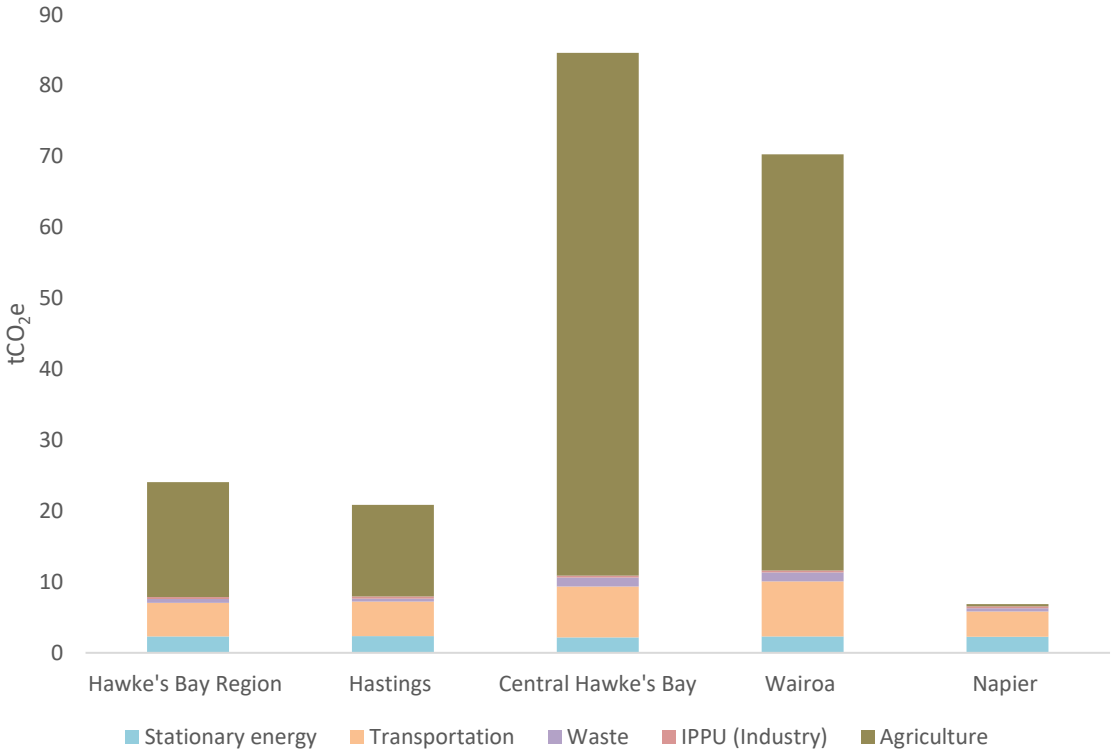
Figure 7 Total gross emissions by territorial authority in the Hawke's Bay region (tCO_2e). *Taupō and Rangitīkei totals only include emissions produced in the Hawke's Bay region.



When comparing emissions inventories from different areas, a per capita figure can be useful because it provides a common reference point to understand the difference in emissions. Figure 8 shows emissions per capita for the region and territorial authorities within the region. Taupō and Rangitīkei are excluded from this figure due to the tiny population and large agriculture within the small area in the Hawke's Bay creating very large per capita emissions (this is not the case for the entire Taupō or Rangitīkei district).

The Hawke's Bay region has a 24.1 tCO_2e/per capita figure for total gross emissions which is higher than the national value of 15.7 tCO_2e/per capita. Notably, Napier has the lowest per capita total emissions at 6.9 tCO_2e/per capita. Central Hawke's Bay and Wairoa have the largest per capita total gross emissions at 84.6 tCO_2e/per capita and 70.3 tCO_2e/per capita respectively, both due to high Agriculture emissions in the district. Hastings has the third highest per capita emissions at 20.9 tCO_2e/per capita, similar to that of the region.

Figure 8 Total gross emissions per capita for the region and territorial authorities within the region (tCO_2e). *Taupō and Rangitīkei areas not included



4.0 Emissions change from 2018/19 to 2020/21

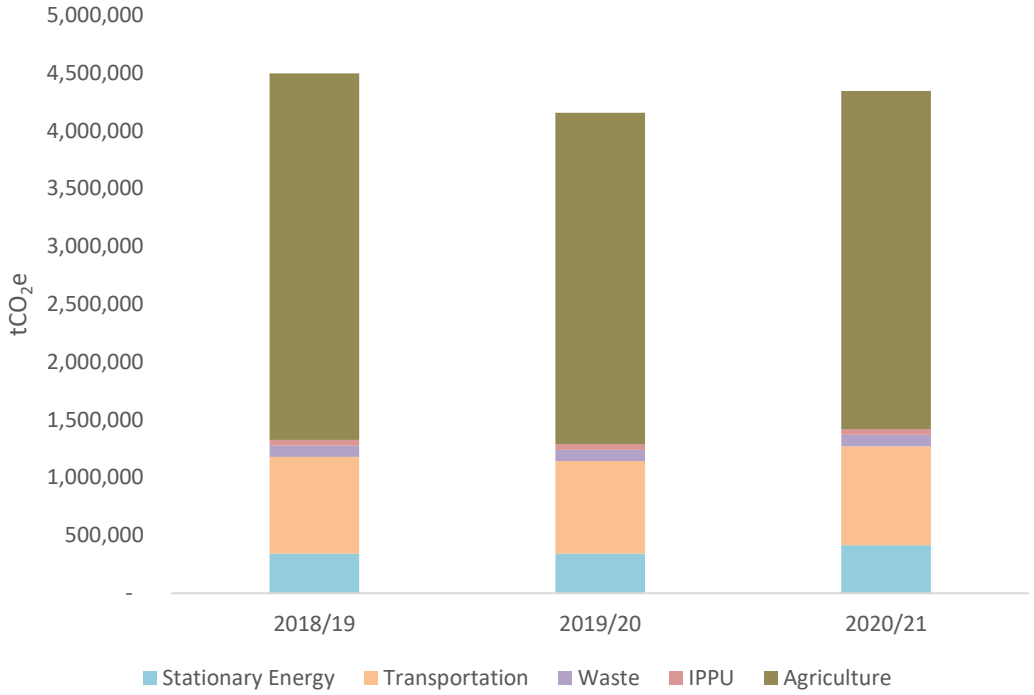
Alongside calculating The Hawke's Bay's emissions footprint for 2020/21, we have calculated the Hawke's Bay's emissions footprint for 2018/19 and 2019/20. This section displays the results of the 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on Gross emissions and documents the change in emissions from 2018/19 to 2020/21.

This section displays the results of the 2018/19, 2019/20, and 2020/21 emissions footprints with a focus on Gross emissions and documents the change in emissions from 2018/19 to 2020/21.

Table 13 Change in The Hawke's Bay's Total Gross and Net emissions from 2018/19 to 2020/21

	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total Net Emissions (including forestry)	1,855,570	1,413,954	1,483,156	-20%
Total Gross Emissions (excluding forestry)	4,497,263	4,155,767	4,345,997	-3%

Figure 9 Change in The Hawke's Bay's total gross emissions from 2018/19 to 2020/21



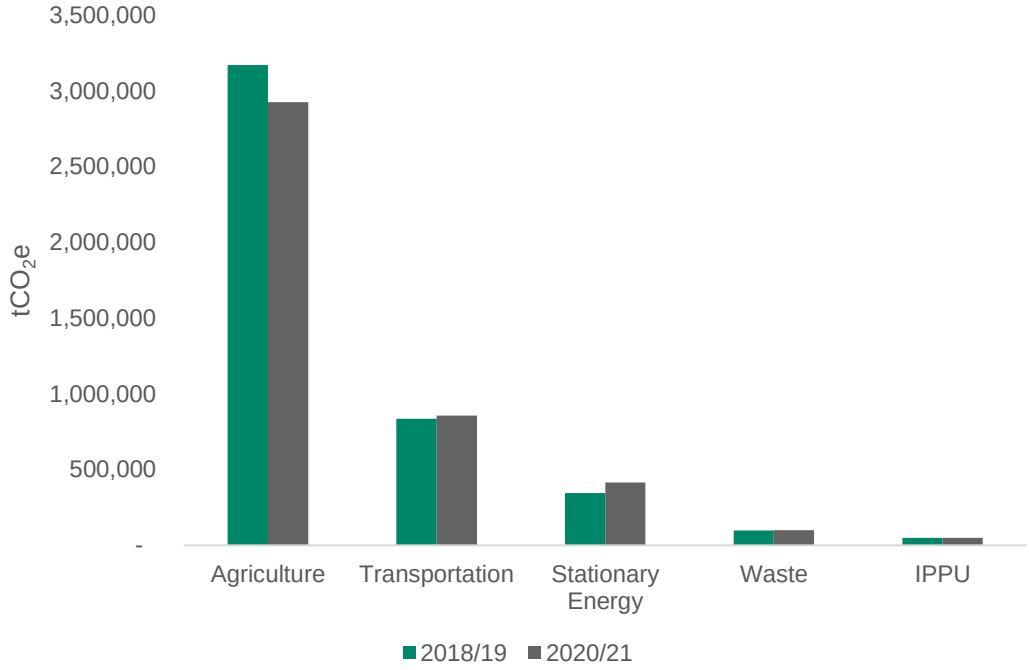
Total gross emissions per year decreased by 3% from 4,497,263 tCO_2e in 2018/19 to 4,345,997 tCO_2e in 2020/21. This was driven by a decrease in Agricultural emissions of 8%, between 2018/19 and 2020/21 (245,553 tCO_2e), due to a reduction in livestock numbers, particularly of sheep and non-dairy cattle.

Total net emissions in Hawke's Bay decreased by 20% from 1,855,570 in 2018/19 to 1,483,156 tCO_2e. This decrease was predominantly due to a decrease in annual forest harvesting emissions. This is discussed further below under the 'Forestry' heading.

The population of Hawke's Bay grew by 4% during this time, resulting in a 7% reduction in per capita gross emissions between 2018/19 and 2020/21, from 25.9 to 24.1 tCO_2e per person per year. A discussion of the decoupling of gross emissions from population growth and economic growth is found in Section 5.0.

The sections below outline the change in emissions between 2018/19 and 2020/21 for each sector and emissions source, highlighting the changes that have had the largest impact on total gross emissions.

Figure 10 Emissions for each sector of The Hawke's Bay's gross emissions footprint for 2018/19 and 2020/21



4.1 Agriculture

Table 14 Change in Hawke's Bay's Agriculture emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Enteric fermentation	2,457,058	2,219,534	2,274,432	-7%
Manure from Grazing Animals	360,412	324,471	332,570	-8%
Other Agriculture Emissions	147,558	132,002	132,079	-10%
Atmospheric Deposition	101,881	91,618	93,329	-8%
Manure Management	51,814	47,881	47,822	-8%
Agricultural Soils	29,657	25,712	22,614	-24%
Fertiliser used in Horticulture	23,070	23,070	23,070	*N/A*
Total	**3,171,449**	**2,864,287**	**2,925,915**	**-8%**

Agriculture is the most significant contributor to the Hawke's Bay's community carbon footprint. The sector's emissions decreased by 8% between 2018/19 and 2020/21 (245,533 tCO_2e). This decrease is driven by a reduction in total livestock numbers, especially of dairy cattle and sheep (see Table 15 and Table 16.

Emissions related to sheep decreased by 149,172 tCO_2e due to a reduction in the number of sheep (272,146 sheep). Emissions related to non-dairy cattle decreased by 60,255 tCO_2e due to a reduction in the number of non-dairy cattle (30,490 cattle). The number of dairy cattle also reduced, reducing dairy cattle emissions by 20,394 tCO_2e.

Table 15 Change in The Hawke's Bay's livestock numbers from 2018/19 to 2020/21

	Number of animals (2018/19)	Number of animals (2020/21)	Change in number of animals (2018/19 to 2020/21)
Sheep	2,876,262	2,604,116	-272,146
Non-dairy Cattle	448,764	418,274	-30,490
Dairy Cattle	78,002	72,208	-5,794
Other livestock	71,257	71,414	157
Total livestock	**3,474,285**	**3,166,012**	**-308,273**

Table 16 Change in the Hawke's Bay's livestock-associated Agriculture emissions from 2018/19 to 2020/21

	2018/19 emissions (tCO_2e)	2020/21 emissions (tCO_2e)	Change in emissions, 2018/19 to 2020/21 (tCO_2e)
Sheep	1,576,576	1,427,404	-149,172
Non-dairy Cattle	1,133,035	1,072,780	-60,255
Dairy Cattle	313,700	293,306	-20,394
Other livestock	67,427	65,709	-1,718
Total livestock	**3,090,738**	**2,859,199**	**-149,172**

4.2 Transport

Table 17 Change in Hawke's Bay's Transport emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Diesel	433,808	421,738	472,063	9%
Petrol	301,531	281,543	300,868	0%
Marine Freight	90,698	90,634	78,488	-13%
Jet Kerosene	3,820	3,293	2,635	-31%
Rail	3,160	861	647	-80%
LPG	1,460	1,477	1,546	6%
Aviation Gas	222	265	272	23%
Total:	**834,698**	**799,813**	**856,520**	**3%**

Transport emissions increased by 3% between 2018/19 and 2020/21 (21,822 tCO_2e). This was driven by a 5% increase in on-road fuel emissions (30,363 tCO_2e) combined with a 13% decrease in marine freight emissions (12,210 tCO_2e).

It is noted the impact of the COVID-19 pandemic can be seen in Transport emissions where emissions decreased by 4% between 2018/19 and 2019/20 due to reductions in road and air transport fuel use. Aviation emissions continued to reduce in the 2020/21 reporting year, reflective of ongoing COVID-19 impacts to the industry.

4.3 Stationary Energy

Table 18 Change in Hawke's Bay's Stationary Energy emissions from 2018/19 to 2020/21

Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Electricity Consumption	125,197	129,010	181,396	45%
Natural Gas	120,436	117,023	125,465	4%
Stationary Petrol & Diesel Use	48,276	46,850	52,339	8%
Coal	12,690	13,259	10,343	-18%
LPG	11,573	11,713	12,261	6%
Electricity Transmission and Distribution Losses	10,931	11,308	16,663	52%
Natural Gas Transmission and Distribution Losses	9,737	9,461	10,143	4%
Biofuel / Wood	5,414	5,424	5,447	1%
Biogas (landfill)	92	93	96	4%
Total:	**344,347**	**344,141**	**414,152**	**20%**

Emissions from Stationary Energy increased by 20% between 2018/19 and 2020/21 (69,806 tCO_2e). This was driven by a 45% increase in electricity consumption emissions (56,198 tCO_2e). This rise in electricity consumption emissions was caused by a 3% increase in electricity consumption in the Hawke's Bay coupled with a 41% increase in the emissions intensity of the national electricity grid (tCO_2e/kWh). The emissions intensity of the national grid has increased in recent years due to the increased use of fossil fuels during years with low hydro electricity generation.

4.4 Waste

Table 19 Change in Hawke's Bay's Waste emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Waste in open landfill sites	57,126	58,590	60,295	6%
Waste in closed landfill sites	15,380	14,533	13,743	-11%
Individual septic tanks	5,655	6,199	6,623	17%
Wastewater treatment plants	7,682	7,240	7,673	0%
Composting	11,125	11,125	11,125	0%
Total	**96,968**	**97,686**	**99,459**	**3%**

Waste emissions increased between 2018/19 and 2020/21, by 3% (2,491 tCO_2e). Total solid waste in landfill emissions increased by 2%. Emissions from closed landfills decreased due to no extra waste being added, the existing waste in landfill releases fewer emissions over time. Emissions from waste in

open landfills increased as the volume of waste entering the landfill increased, and waste recently deposited in landfill reaches peak emissions per year (this is after approximately two years in landfill). Due to data only being available for one singular year, no change in composting emissions is recorded.

Total wastewater emissions increased by 7%, due to the increase in emissions from individual septic tanks (968 tCO_2e). Better data on the number of households connected to centralized wastewater treatment would improve the accuracy of the emissions calculations. Due to the production of methane, septic tanks have a higher emissions intensity compared to a wastewater treatment plant.

4.5 Industrial Processes and Product Use (IPPU)

Table 20 Change in Hawke's Bays IPPU emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Refrigerants and air conditioning	46,065	46,242	46,441	1%
Aerosols	2,899	2,707	2,601	-10%
SF6 - Electrical Equipment	457	493	508	11%
Foam Blowing	202	219	220	9%
SF6 - Other	99	99	100	1%
Fire extinguishers	80	80	80	0%
Total	**49,802**	**49,840**	**49,950**	**0.3%**

IPPU emissions remained stable between 2018/19 and 2020/21. There was a decrease in aerosols emissions (298 tCO_2e) and an increase in refrigerants and air conditioning (376 tCO_2e). Note that national level data is used for this sector and is portioned out using a population approach; exact emissions for the Region are unknown.

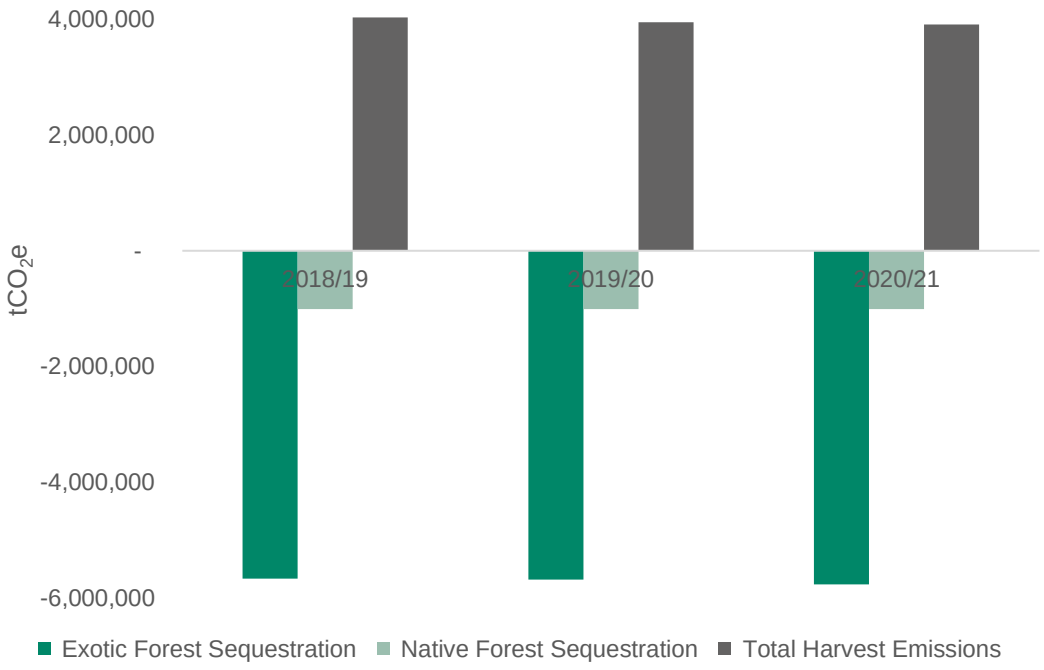
4.6 Forestry

Table 21 Change in Hawke's Bays Forestry emissions from 2018/19 to 2020/21

Sector / Emissions Source	2018/19 (tCO_2e)	2019/20 (tCO_2e)	2020/21 (tCO_2e)	% Change (2018/19 to 2020/21)
Total harvest emissions	4,026,465	3,945,810	3,908,023	-3%
Native forest sequestration	-1,007,992	-1,007,992	-1,007,992	0%
Exotic forest sequestration	-5,660,165	-5,679,631	-5,762,872	2%
Total	-2,641,693	-2,741,813	-2,862,841	8%

Forestry emissions decreased by 221,148 tCO_2e (8%) between 2018/19 and 2020/21. This decrease was driven by a decrease in total harvest emissions (118,442 tCO_2e) and an increase in exotic forest sequestration during this time. Forestry emissions are influenced by the cyclical nature of harvesting and planting regimes where some years will have higher sequestration and some years will have higher harvesting emissions. This is dependent on age of forests and the demand for lumber and timber. Improved and updated data sources may impact the estimation of emissions from this source in the future.

Figure 11 Forestry sequestration and harvesting emissions from 2018/19 to 2020/21



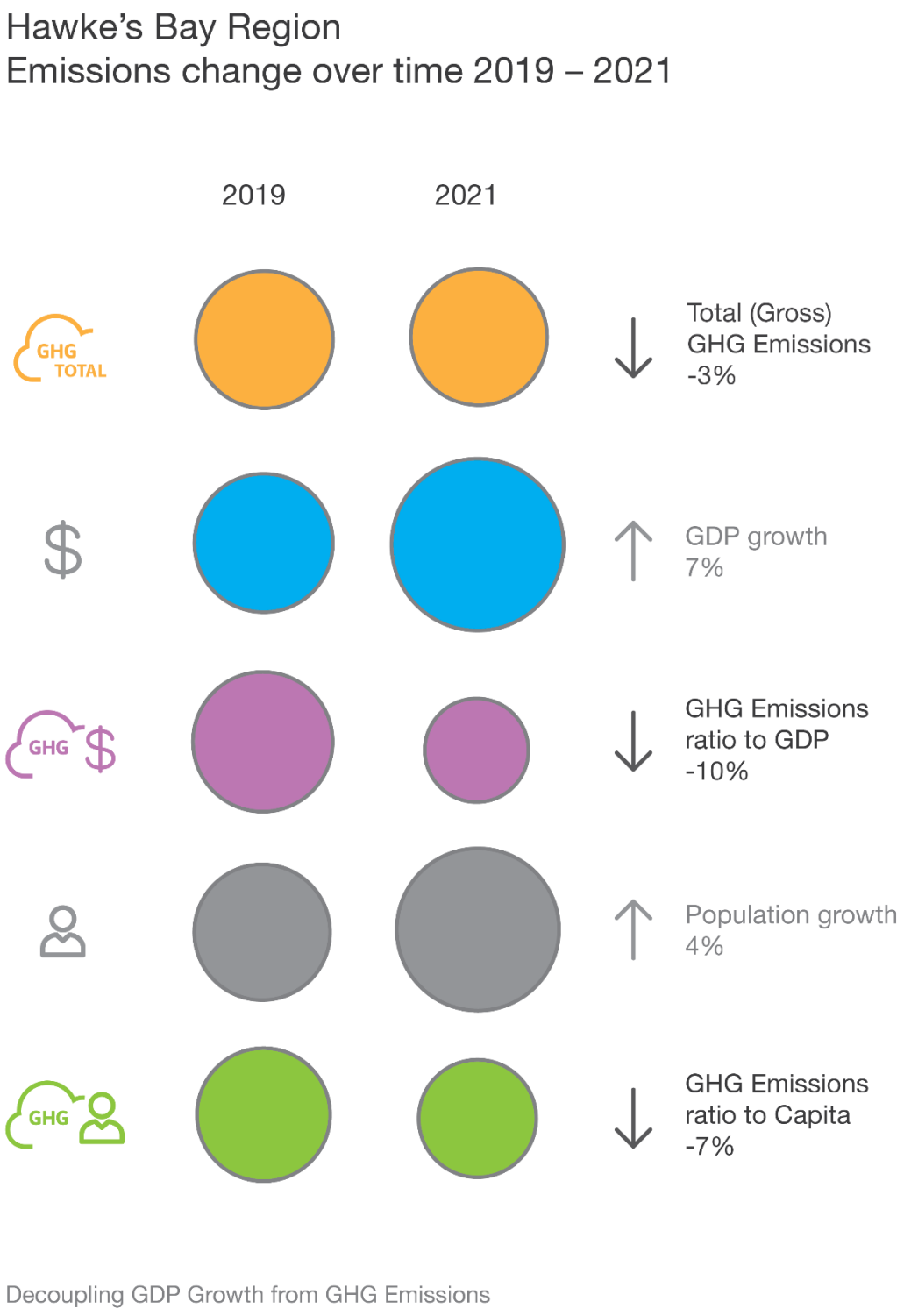
5.0 Decoupling of GHG emissions from population growth and GDP

Figure 12 shows the change in gross emissions when compared to changes in other metrics of interest between 2018/19 and 2020/21. For example, total gross emissions have decreased by 3% as the population has grown by 4%, resulting in a 7% decrease in per capita gross emissions.

When emissions grow less rapidly than Gross Domestic Product (GDP) as a measure of regional income then this process is known as decoupling. The term decoupling is an expression of the desire to mitigate emissions without harming economic wellbeing. A full discussion of decoupling of emissions is beyond the scope of this project. However, the changes in emissions and GDP illustrated in Figure 12 suggest at a high-level decoupling has occurred between 2018/19 and 2020/21. GDP increased by 7% while gross emissions decreased by 3%, resulting in a 10% decrease in the GHG emissions ratio to GDP.

The exact drivers for the decoupling of emissions from GDP are difficult to pinpoint. New policies, for restructuring the way to meet demand for energy, food, transportation, and housing will all contribute. In this case, both direct local actions including reducing the emissions from landfill gas and indirect national trends (e.g. reduction of emissions from electricity generation) will have contributed to the trends noted.

Figure 12 Change in total gross emissions compared to other metrics of interest



6.0 Impact of the COVID-19 pandemic on GHG Emissions

COVID-19 impacted New Zealand and the entire world during 2020 and 2021, causing widespread government-imposed restrictions on businesses and individuals and huge shifts in behaviours and economic markets. Restrictions in New Zealand relating to COVID-19 began in mid-March 2020 with many personal and business restrictions continuing past the end of 2019/20 and throughout 2020/21.[3]

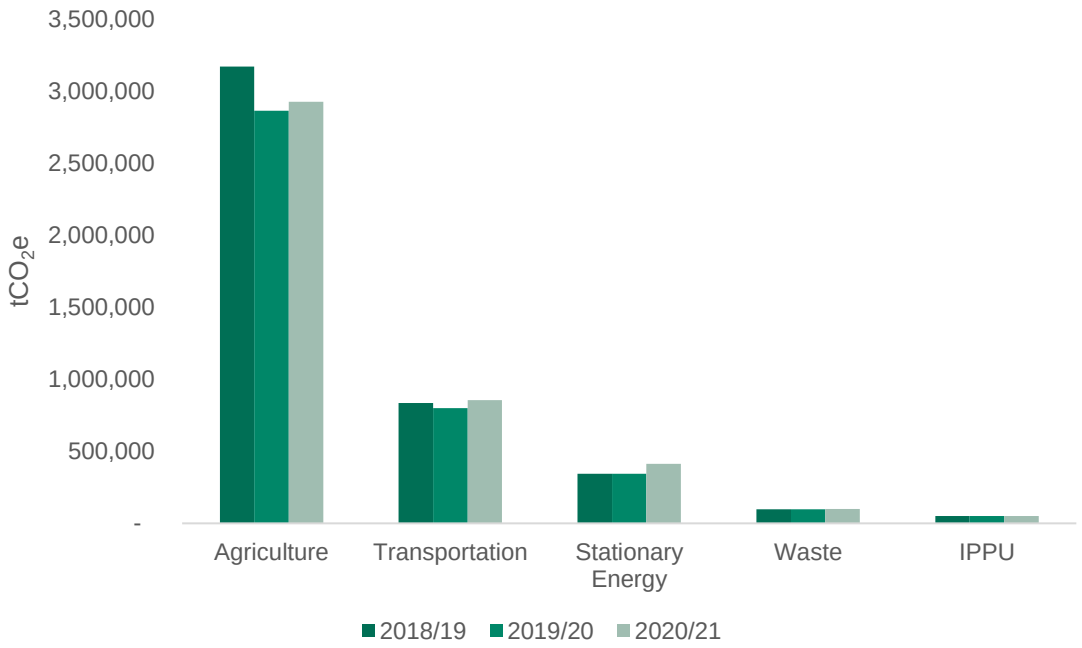
Globally, carbon dioxide emissions from fossil fuels (the largest contributor to greenhouse gas emissions) in 2020 decreased by 7% compared to 2019[4]. Emissions from the transportation sector account for the largest share of this decrease. Surface transport, e.g. car journeys, fell by approximately half at the peak of COVID-19 restrictions in April 2020 (when restrictions were at their maximum, particularly across Europe and the U.S. Globally, emissions recovered to near 2019 levels in 2021 and are expected to continue to increase.

In New Zealand, national daily carbon dioxide emissions are estimated to have fell by up to 41% during the level 4 lockdown in April 2020[5]. National gross emissions decreased by 3% from 2018/19 to 2019/20, which was largely driven by a decrease in fuel use in road transport due to COVID-19 pandemic restrictions, a decrease in fuel use in manufacturing industries and construction due to COVID-19 restrictions, and a decrease in fuel use from domestic aviation also due to COVID-19 restrictions.

Total gross emissions in the Hawke's Bay decreased by 341,496 tCO_2e (8%) between 2018/19 and 2019/20. Total gross emissions then increased by 190,229 tCO_2e (4%) from 2019/20 to 2020/21, however this is still lower than the pre-covid-19 2018/19 year.

The impact on emissions in different sectors varied. Notably, Transport emissions reduced by 4% between 2018/19 and 2019/20, driven by reduced on-road and off-road transport fuel use. Agriculture emissions reduced between 2018/19 and 2019/20, potentially due to impacts on transport and global supply chains. Despite changes in Stationary Energy emissions, this sector is not judged to have been significantly affected by COVID-19. Waste and IPPU emissions were relatively unchanged between 2018/19 and 2019/20.

Figure 13 Hawke's Bay emissions per sector for 2018/19, 2019/20, and 2020/21 (tCO_2e)



[3] https://covid19.govt.nz/alert-system/history-of-the-covid-19-alert-system/
[4] Pierre Friedlingstein et al. - Global Carbon Budget 2020 (2020)
[5] Corinne Le Quere et al. – Temporary Reduction in Daily Global CO_2 Emissions During the COVID-19 Forced Confinement

7.0 Closing Statement

The Hawke's Bay GHG emissions footprint provides information for decision-making and action by the council, stakeholders, and the wider community. We encourage the council to use the results of this study to update current climate actions plans and set emission reduction targets.

The emissions footprint developed for the Hawke's Bay region covers emissions produced in the Stationary Energy, Transport, Waste, IPPU, Agriculture, and Forestry sectors using the GPC reporting framework. Sector-level data allows the Hawke's Bay Regional Council to target and work with the sectors that contribute the most emissions to the footprint.

Understanding of the extensive and long-lasting effects of climate change is improving all the time. It is recommended that this emissions footprint be updated regularly (every two or three years) to inform ongoing positive decision making to address climate change issues.

The accuracy of any emissions footprint is limited by the availability, quality, and applicability of data. Areas where data could be improved for future footprints include forestry (forest cover and harvesting), agriculture (especially livestock numbers), solid waste and wastewater, and on and off-road transport fuel use.

8.0 Limitations

Where this Report indicates that information has been provided to AECOM by third parties, AECOM has made no independent verification of this information except as expressly stated in the Report. AECOM assumes no liability for any inaccuracies in or omissions to that information. This Report was prepared between **June 2022 and September 2022** and is based on the information reviewed at the time of preparation. AECOM disclaims responsibility for any changes that may have occurred after this time. This Report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This Report does not purport to give legal advice.

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Appendix A

Assumptions and Data Sources

Sector / Category	Assumption and Data Sources
General	
Geographical Boundary	LGNZ local council mapping boundaries have been applied. The emissions footprint for the Hawke's Bay Region covers the entirety of the Hawke's Bay Region (this excludes some of the Rangitikei and Taupō territorial authorities). Emissions footprints for each territorial authority covers the entirety of the territorial authority area.
Population	Population figures are provided by StatsNZ. Financial year populations have been used, these are based on the average population from the two calendar years (e.g. the average of 2018 and 2019 calendar year populations for FY19). The population of Taupo and Rangitikei Districts within the Hawke's Bay geographical boundary has been calculated.
Transport Emissions	
Petrol and Diesel:	Petrol and diesel sales data provided by Napier City Council for Napier, Central Hawke's Bay and Hastings. Combined sales data for Gisborne and Wairoa provided by Gisborne District Council and allocated to a region based on Waka Kotahi emissions data. Sales have been divided between territorial authorities based on the number of kilometres travelled by vehicles on roads (VKT) in each territorial authority. VKT data provided by Waka Kotahi. The division into transport and stationary energy end use (and within transport into on-road and off-road) has been calculated using fuel end use data provided by the Energy Efficiency and Conservation Authority (EECA) from the 2019 database. Biofuel sales information provided directly by the supplier.
Rail Diesel	Emissions from fuel use have been calculated and provided by Kiwi Rail. The following assumptions were made: - Net Weight is product weight only and excludes container tare (the weight of an empty container) - The Net Tonne-Kilometres (NTK) measurement has been used. NTK is the sum of the tonnes carried multiplied by the distance travelled. - National fuel consumption rates have been used to derive litres of fuel for distance. - Type of locomotive engine used, and jurisdiction topography, have not been incorporated in the calculations. The trans-boundary routes were determined, and the number of stops taken along the way derived. The total amount of litres of diesel consumed per route was then split between the departure district, arrival district and any district the freight stopped at along the way. If the freight travelled through but did not stop within a district, no emissions were allocated. This data is subject to commercial confidentiality.
Jet Kerosene (Scheduled Flights) Aviation Gas (General Aviation)	Calculated from information provided by Hawke's Bay Airport. Aviation fuel and jet kerosene fuel volumes were provided and emissions have been calculated using these volumes. Emissions have been divided between territorial authorities based the relative population of each territorial authority.

Marine Freight	Shipping schedules have been provided by the Port of Napier. Emissions have been calculated based on ship weight and distance from the origin/destination to Napier. This figure does not include fishing vessels, or vessels with destination to be confirmed. Emissions from freight and international shipping are allocated equally between the origin and destination area emissions footprints. It is expected that imports and exports travelling through the Port of Napier service the entire Hawke's Bay Region. Emissions relating to freight and international shipping emissions have been divided between all Hawke's Bay territorial authorities based on population size.
Marine Fuel (Local)	Non-freight marine fuel use has not been included in this study. Fuel use by Port of Napier-controlled vessels has not been included due to a lack of available information. Most private marine vessels use fuel purchased at vehicle fuel stations. Petrol and diesel used in private marine vessels is included in off-road transportation.
LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. Sales have been divided between territorial authorities on a per capita basis.
Stationary Energy Emissions	
Electricity Demand	Electricity demand has been calculated using grid exit point (GXP) data from the EMI website (www.emi.ea.govt.nz). Reconciled demand has been used as per EMI's confirmation. The territorial authorities serviced by each GXP have been confirmed by the respective electricity suppliers. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per Ministry for the Environment (MfE) data.
Electricity Generation	Electricity generation has been calculated using data from the EMI website (www.emi.ea.govt.nz). Small electricity generation has not been included in this data (e.g. domestic solar generation). This figure only includes electricity that is connected to the national electricity grid, direct users of electricity are not included.
Coal Consumption	National coal consumption data has been provided by MBIE. Regional industrial coal data has been provided by EECA. National residential and commercial coal consumption has been divided between territorial authorities on a per capita basis. Regional industrial coal consumption has been divided between territorial authorities on a per capita basis.
Coal Production and Fugitive Emissions	Not Calculated: There are no active coal mines within the region.
Biofuel Consumption	National biofuel consumption data has been provided by the Ministry for Business, Innovation and Employment (MBIE). Biofuel consumption has been divided between territorial authorities on a per capita basis. Biofuel emissions are broken down into Biogenic emissions (CO_2) and Non-Biogenic emissions (CH_4 and N_2O)

LPG Consumption	North Island LPG sales data (tonnes) has been provided by the LPG Association. 'Auto' and 'Forklift' sales represent transport uses of LPG. All other sales represent stationary energy uses of LPG. Sales have been divided between territorial authorities on a per capita basis. The breakdown into sectors (Residential, Commercial, and Industrial) is based on NZ average consumption per sector as per MfE data.
Natural Gas Consumption	Natural gas consumption data has been provided by FirstGas. Territorial Authorities supplied by gas from each Point of Connection (POC) have been confirmed by FirstGas. Natural gas consumption has been split into residential, commercial, and industrial consumption based on information provided by PowerCo and national statistics from MBIE. Some POCs supply gas to particular industrial users exclusively, these have been taken into account.
Oil and Gas Fugitive Emissions	Not Calculated: There are no gas or oil processing plants within the region.
Agricultural Emissions	
General	Territorial authority livestock numbers and fertiliser data taken from the Agricultural Census (StatsNZ). The last territorial authority census was in 2017. Regional agricultural data from StatsNZ (2021) has been used to estimate the change in livestock and fertiliser use since 2017. Territorial authority land-use data provided by HBRC covering horticulture land-use.
Solid Waste Emissions	
Waste in Landfill	Landfill waste volume and end location information has been provided by the respective council departments. Where information is not available, waste volumes have been estimated based on historical national data on a per capita basis. Emissions are allocated to territorial authorities based on where the waste was produced, even if the waste is disposed in landfill outside the territorial authority.
Wastewater Emissions	
Wastewater Volume and Treatment Systems	Information on treated wastewater, and treatment plants has been provided by the respective council departments. Where information is not available, reasonable assumptions have been made and the WaterNZ database has been consulted. The population connected to septic tank systems have been estimated by the respective council departments. Where the population covered by Wastewater treatment plants and septic tanks does not account for the entire population, the remaining population is assigned to septic tanks. Emissions are allocated to territorial authorities based on where the wastewater was produced, even if the wastewater is treated outside the territorial authority.
Industrial Emissions	
Industrial processes	It is assumed that there are no significant non-energy related emissions of greenhouse gasses from industrial processes in the Region (e.g. aluminium manufacture).
Industrial Product Use	National data covering industrial product use (e.g. fire extinguishers, refrigerants) has been provided by the MfE. Emissions have been allocated to territorial authorities on a per capita basis.

Forestry Emissions	
Exotic Forestry Harvested	Harvested forestry, and forest cover information for each territorial authority has been derived from Landcare Research data. It has been assumed that only 70% of the tree is removed as roundwood and that the above ground tree makes up approximately 74% of the total carbon stored.
Exotic Forest	Exotic forest land area for each territorial authority has been provided by Landcare Research.
Emission Factors	
General	All emission factors have detailed source information in the calculation tables within which they are used. Where possible, the most up to date, NZ-specific EFs have been applied. AR5 Global Warming Potential (GWP) figures for greenhouse gases have been used accounting for climate change feedbacks.

Appendix B

Additional Transport Emissions Analysis

Additional Transport Emissions Analysis – Hawke's Bay Region

This section details the additional analysis undertaken to further breakdown the Hawke's Bay Region's transport sector GHG emissions. The focus of this additional analysis addresses on-road and off-road transport emissions which together represent 18% of Hawke's Bay total gross emissions. Within on-road and off-road transport emissions this assessment looks at the relative contribution of each vehicle type (Cars, Commercial Vehicles, Buses) to the region's transport emissions.

Key findings:

- Cars represent 51% of Hawke's Bay on-road transport emissions, and 8% of Hawke's Bay total gross emissions.
- Light commercial vehicles represent 22% of Hawke's Bay's on-road transport emissions and 3% of Hawke's Bay's total gross emissions.
- Heavy commercial vehicles represent 24% of Hawke's Bay's on-road transport emissions and 4% of Hawke's Bay's total gross emissions.
- Electric vehicles currently represent less than 106 tCO_2e (0.02%) of Hawke's Bay on-road transport emissions based on emissions related to the electricity consumed.
- Cars represent 73% of all Vehicle Kilometres Travelled (VKT) in Hawke's Bay but represent 51% of all on-road emissions in Hawke's Bay. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles.
- 25-50+ tonne heavy vehicles represent 4% of all Vehicle Kilometres Travelled (VKT) in Hawke's Bay but represent 18% of all on-road emissions in Hawke's Bay.
- Diesel is the predominant fuel for off-road transport use, representing 95% of off-road transport emissions in Hawke's Bay.
- Nationally, agriculture is the highest producing sector of off-road transport emissions, producing 27% of all off-road transport emissions. The next largest off-road transport producing sectors are building and construction, commercial, and industrial uses. Data specific to Hawke's Bay was not available at the time of writing.

1.0 Methodology

The basis for this assessment is the results presented in the Hawke's Bay Community Carbon Footprint for the financial year 2020/21 (July 1st to June 30th). The emissions for on-road and off-road transport have been calculated directly based on the sale of petrol and diesel in Hawke's Bay, and then these have been broken down by sector and vehicle type using data provided by Waka Kotahi and the Energy Efficiency and Conservation Authority (EECA).

Data provided by Waka Kotahi covering Vehicle Kilometres Travelled (VKT) and emissions (by gas) for each territorial authority by vehicle class in 2018/19 has been used to assess the relative contribution of vehicle class types to on-road transport emissions in Hawke's Bay.

Emissions related to energy use from electric vehicles (EVs) in the Community Carbon Footprint is included in the Stationary Energy sector and not included in transport emissions, due to lack of available data at the time of calculation. Total emissions presented here include the EV emissions contribution. These emissions have been calculated using an average electricity consumption per km travelled and based on the carbon intensity of the national electricity grid in 2020/21.

All calculated emissions have been converted to tonnes of CO_2 equivalent (tCO_2e) to allow direct comparison with the results of the Community Carbon Footprint.

Off-road transport data is limited at the local level, so this assessment utilises national data provided by the EECA to determine the relative contribution of emission sources within the on-road transport emissions source.

2.0 Key Limitations

On-road transport

- The data underlying the breakdown of on-road transport emissions is based on calendar year 2019 data, not financial year 2020/21. There may be some differences between these years regarding the vehicle fleet make-up, but it expected that the proportions used are representative.

Off-road transport

- Calculations have been based on national-level data resulting in a lower level of confidence in their applicability to the territorial authority's off-road emissions given the variation in off-road transport uses across the country.
- In the Community Carbon Footprint, recreational marine fuel usage is included in 'off-road transport' due to the lack of data able to separate this marine fuel consumption from other on-land fuel consumption. This recreational marine fuel is estimated and included in 'off-road transport' here for consistency.

Marine freight transport, air travel, and rail

- These emissions sources have not been broken down further. Additional work could be done to separate cruise ships from marine freight (although there is limited available and reliable data to do so). Additional work could also assess the relative contribution of the origin and destination of marine and air travel movements. These are beyond the scope of this study.

3.0 Transport Emissions Summary

The paragraphs, figures and tables below outline Hawke's Bay greenhouse gas emissions from transport. During the 2020/21 reporting period, transport in Hawke's Bay emitted 856,520 tCO_2e, representing 20% of Hawke's Bay total gross emissions.

On-road transport is the largest contributor to Transport emissions, representing 80% of Transport emissions and 16% of Hawke's Bay total gross emissions. This is followed by off-road transport and marine transport (all relating to marine freight).

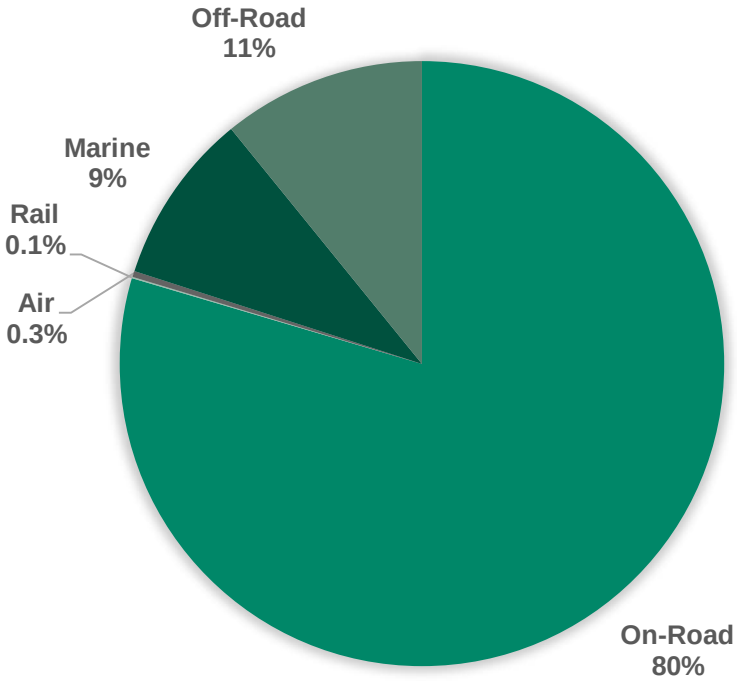

Figure 1 Hawke's Bay – transport emissions (tCO_2e)

4.0 On-Road Transport Emissions Breakdown

4.1 Hawke's Bay Region

On-road transport emissions are those relating to cars, commercial vehicles (including utes, trucks, and large commercial vehicles), and buses on-roads.

Table 1 and Figure 2 detail on-road transport emissions per vehicle category. The results show that cars in Hawke's Bay tend to be fuelled by petrol while Commercial Vehicles and Buses almost exclusively use diesel.

Low emission Electric Vehicle (EV) use is currently minimal within the Hawke's Bay resulting in an extremely small contribution to on-road transport emissions (140 tCO_2e). Note that sales and use of electric vehicles have likely increased since 2018/19 (the most recent year available for the dataset used), however emissions will likely still represent an extremely small contribution to on-road transport emissions.

In Hawke's Bay, the largest contributor to on-road transport emissions are cars, representing 51% of on-road transport emissions, and 8% percent of Hawke's Bay's total gross emissions. Commercial vehicles represent 46% of on-road transport emissions, and 7% percent of Hawke's Bay total gross emissions. A further breakdown of commercial vehicle types is provided below.

Table 1 On-road transport emissions by vehicle type and fuel type (tCO_2e)

Vehicle Type	Petrol	Diesel	Electric	Total	% of Total
Cars	295,523	52,210	138	**347,871**	**51%**
Commercial Vehicles	18,171	293,527	0	**311,698**	**46%**
Buses	-	21,824	2	**21,825**	**3%**
Total	**313,693**	**367,561**	**140**	**681,394**	
% of Total	**46%**	**54%**	**0.02%**		

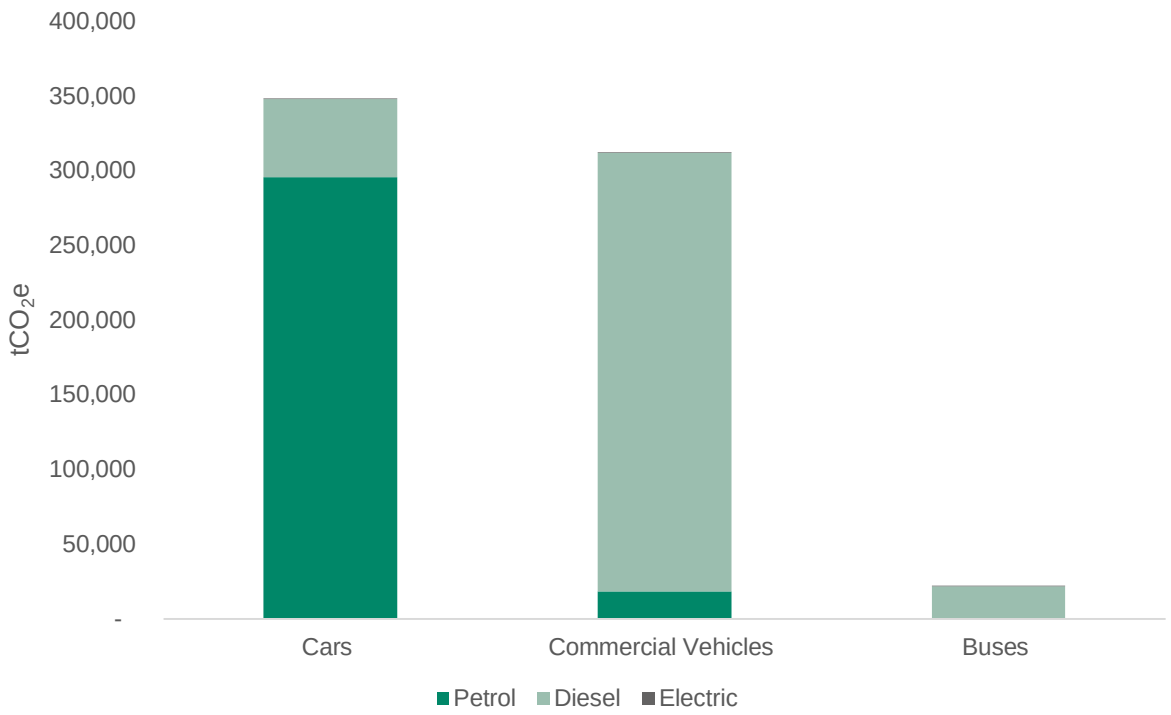

Figure 2 On-road transport emissions by vehicle type and fuel type

In Hawke's Bay, 85% of total car emissions are from petrol, while commercial vehicles are primarily diesel (94% of total commercial vehicle emissions). Buses are almost entirely diesel fuelled and contribute 3% of total vehicle emissions for the region. The busses category includes all busses including public transport, school busses, and private commercial busses (including tourist coaches).

Emissions from these vehicle types can be broken down further by vehicle class. Table 2 and Figure 3 detail on-road transport emissions per vehicle class.

Table 2 On-road transport emissions by vehicle class (tCO_2e)

Vehicle Class	GHG Emissions (tCO_2e)	% of Total
Cars	347,871	51%
Light Commercial Vehicles <3.5 Tonne	151,209	22%
Heavy Vehicles 3.5-25 Tonne	35,460	5%
Heavy Vehicles 25-50+ Tonne	125,029	18%
Bus Urban 15-18 Tonne	19,852	3%
Bus Coach >18 Tonne	1,974	<1%
Total	**681,394**	

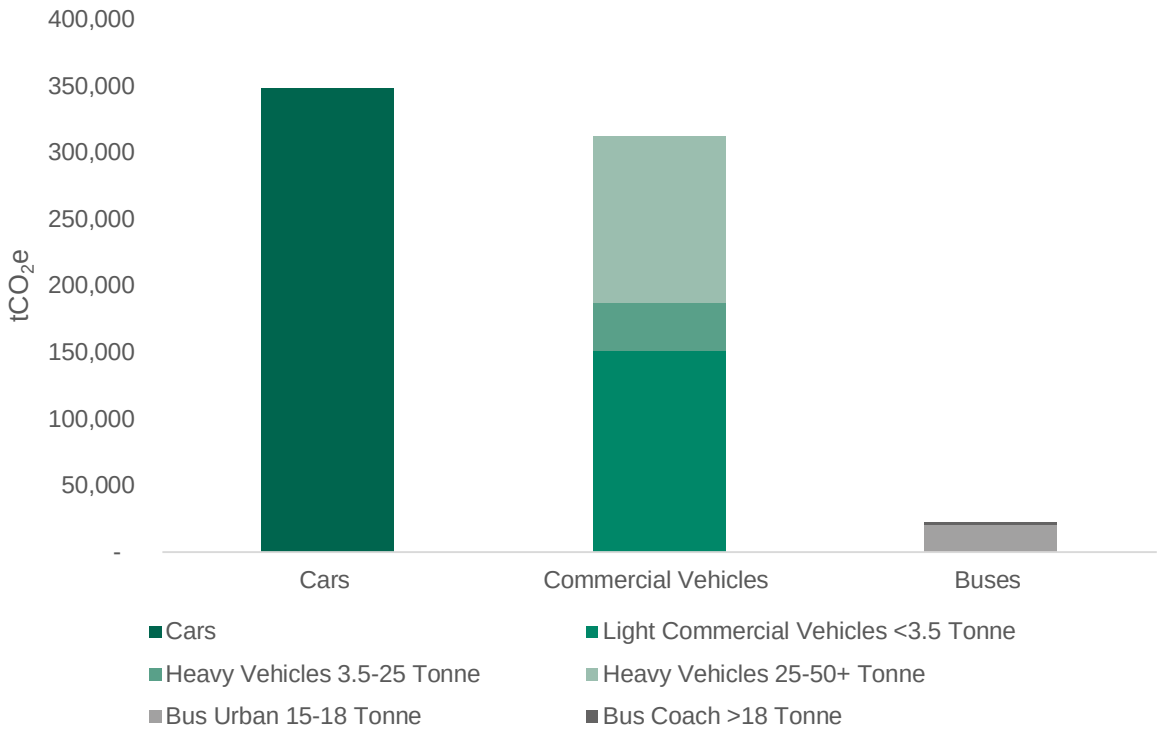

Figure 3 On-road transport emissions by vehicle class

Alongside total transport emissions, we can also look at emissions compared to distance travelled by different vehicle types. Table 3 shows the emissions per vehicle class as above but also includes the Vehicle Kilometres Travelled (VKT) by each vehicle class in Hawke's Bay and shows the average GHG emissions per VKT for each vehicle class. The average GHG emissions per VKT figure was calculated from the distance travelled (as per the Waka Kotahi data) and reported emissions (calculated from fuel sales and broken-down using Waka Kotahi emissions data).

Cars represent 73% of all VKT in Hawke's Bay but represent 51% of all on-road emissions in Hawke's Bay. This is due to the relatively low average tCO_2e per VKT of cars compared to heavier vehicles (which is also partly due to the use of petrol rather than diesel for cars). Despite 25-50+ tonne heavy vehicles representing 4% of all VKT in Hawke's Bay these vehicles represent 18% of all on-road emissions in Hawke's Bay. It is important to note that these figures do not take into account the weight of freight, or the number of people, being moved per vehicle, where larger vehicles may be more efficient per tonne of freight moved than smaller vehicles, or where busses may be more efficient per person than cars.

Efforts to reduce the kilometres travelled by all vehicles should be considered to reduce emissions from on-road transport. This could include enabling and encouraging increased public transport use, or

diverting freight from roads onto rail and marine transport options. Efforts to improve the fuel efficiency of all vehicles should also be considered.

Table 3 On-road transport vehicle class VKT, emissions, and calculated average emissions per VKT

Vehicle Type	Vehicle Kilometres Travelled (VKT)	GHG Emissions (tCO_2e)	Average tCO_2e per VKT
Cars	1,261,391,621	347,871	0.0003
Light Commercial Vehicles <3.5 Tonne	339,983,103	151,209	0.0004
Heavy Vehicles 3.5-25 Tonne	38,335,525	35,460	0.0009
Heavy Vehicles 25-50+ Tonne	71,355,816	125,029	0.0018
Bus Urban 15-18 Tonne	9,975,917	19,852	0.0020
Bus Coach >18 Tonne	1,504,270	1,974	0.0013
Total	**1,722,546,252**	**681,394**	

4.2 Territorial Authorities in Hawke's Bay Region

This section briefly presents the main results of this assessment at the territorial authority level. All calculations and results have been provided to Hawke's Bay Regional Council in excel format.

Due to the differences in geographic boundaries between the territorial authorities and the region, the sum of GHG emissions from the territorial authorities covered here does not equal the emissions for the Hawke's Bay Region.

Table 4 On-road transport emissions by vehicle type and fuel type for the territorial authorities in Hawke's Bay (tCO_2e)

Vehicle Type	Hastings District	Napier City	Wairoa District	Central Hawke's Bay District
Cars	179,692	100,583	24,872	45,264
Commercial Vehicles	157,912	78,847	29,281	42,613
Buses	10,728	5,375	2,247	3,051
Total	**348,332**	**184,805**	**56,400**	**90,928**

Table 5 Proportion of on-road transport emissions by vehicle type and fuel type for the territorial authorities in Hawke's Bay

Vehicle Type	Hastings District	Napier City	Wairoa District	Central Hawke's Bay District
Cars	52%	54%	44%	50%
Commercial Vehicles	45%	43%	52%	47%
Buses	3%	3%	4%	3%

Hastings has the largest amount of GHG emissions across each vehicle type, while Wairoa has the lowest across each vehicle type.

Regarding the proportion of emissions by vehicle type, notably Napier has the highest proportion of car related GHG emissions compared to the other territorial authorities, while Wairoa and Central Hawke's Bay have the highest proportion of commercial vehicle GHG emissions.

On a per capita basis, the lowest on-road car, commercial vehicle and bus emissions are found in Napier while the highest per capita car, commercial vehicle and bus emissions are found in Wairoa and Central Hawke's Bay. Per capita emissions for on-road transport in Hastings and the entire Hawke's Bay region are similar to that of the entirety of New Zealand.

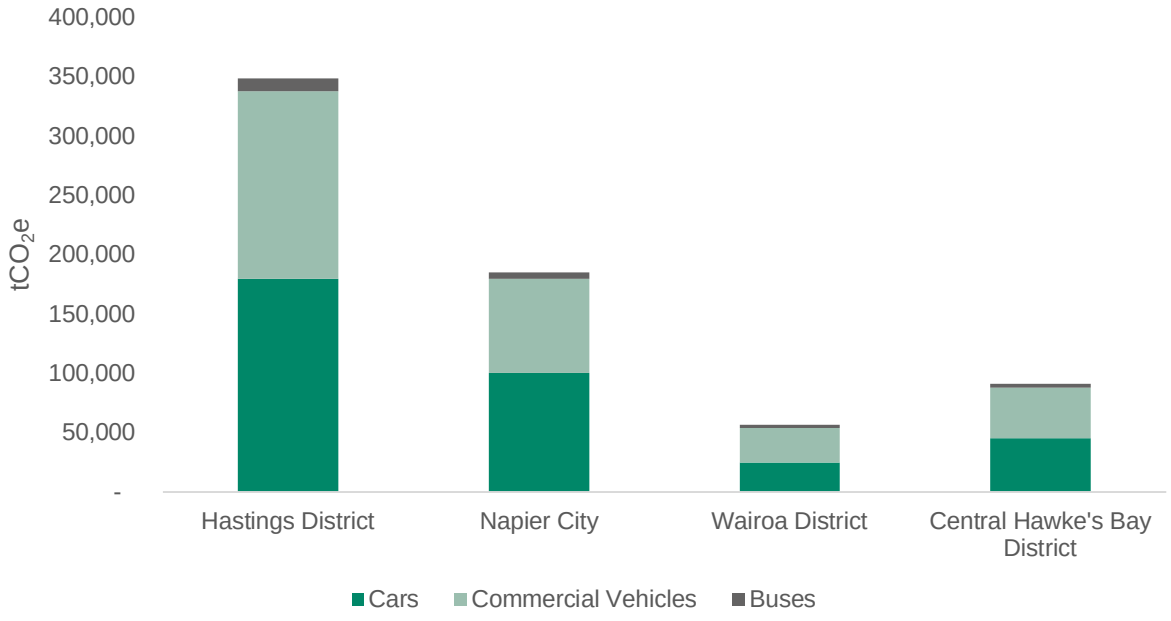

Figure 4 On-road transport emissions by vehicle type for the territorial authorities in the Hawke's Bay Region

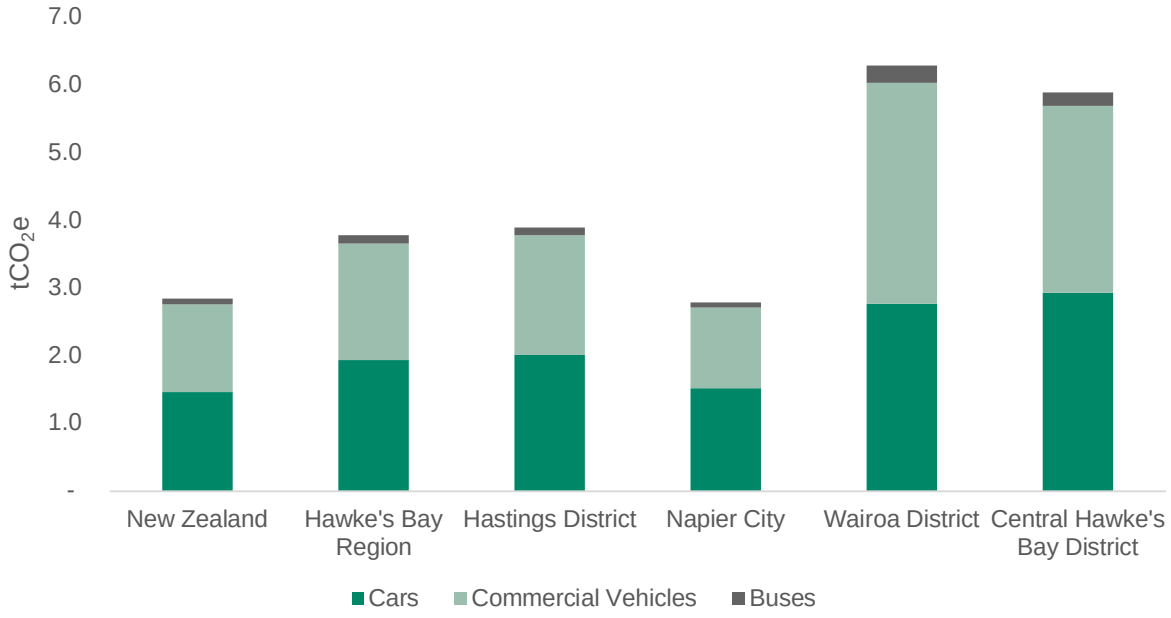

Figure 5 Per capita on-road transport emissions by vehicle type for the territorial authorities in the Hawke's Bay Region and New Zealand

5.0 Off-Road Transport Emissions Breakdown

The off-road transport emissions breakdown by sector is presented in Table 6 and Figure 6. The total off-road petrol and diesel figures are based on the Community Carbon Footprint for Hawke's Bay. These totals have then been allocated to sectors based on the *Off-road liquid fuel insights- Quantifying off-road diesel and petrol use in New Zealand*, July 2021 produced by the Energy Efficiency and Conservation Authority (EECA). It is important to note that the EECA figures used are from 2019 and are based on values for the entirety of New Zealand and are therefore not specific to uses of off-road transport fuels in Hawke's Bay.

The allocation of petrol and diesel to these sectors should be used for context only as they are not robustly reflective of fuel use in Hawke's Bay.

Diesel is the predominant fuel for off-road transport use, representing 95% of off-road transport emissions. Nationally, agriculture is the highest producing sector for off-road transport emissions, producing 27% of all off-road transport emissions. The next largest off-road transport producing sectors are building and construction, commercial, and industrial uses. These figures would likely be significantly different if data for Hawke's Bay was available.

Table 6 Off-road transport emissions by sector type and fuel type (tCO_2e)

Sector Type	Diesel	Petrol	Total	% of Total
Agriculture	24,584	346	**24,930**	**27%**
Fishing & Hunting	3,833	3	**3,837**	**4%**
Forestry & Logging	6,584	1	**6,585**	**7%**
Building & Construction	16,084	2	**16,086**	**17%**
Mining	6,834	-	**6,834**	**7%**
Industrial	11,750	20	**11,770**	**13%**
Commercial	12,417	220	**12,637**	**14%**
Recreational marine	4,167	4,019	**8,186**	**9%**
Marina Refuelling Stations	2,167	52	**2,219**	**2%**
Total	**88,419**	**4,665**	**93,084**	
% of Total	**95%**	**5%**	**-**	

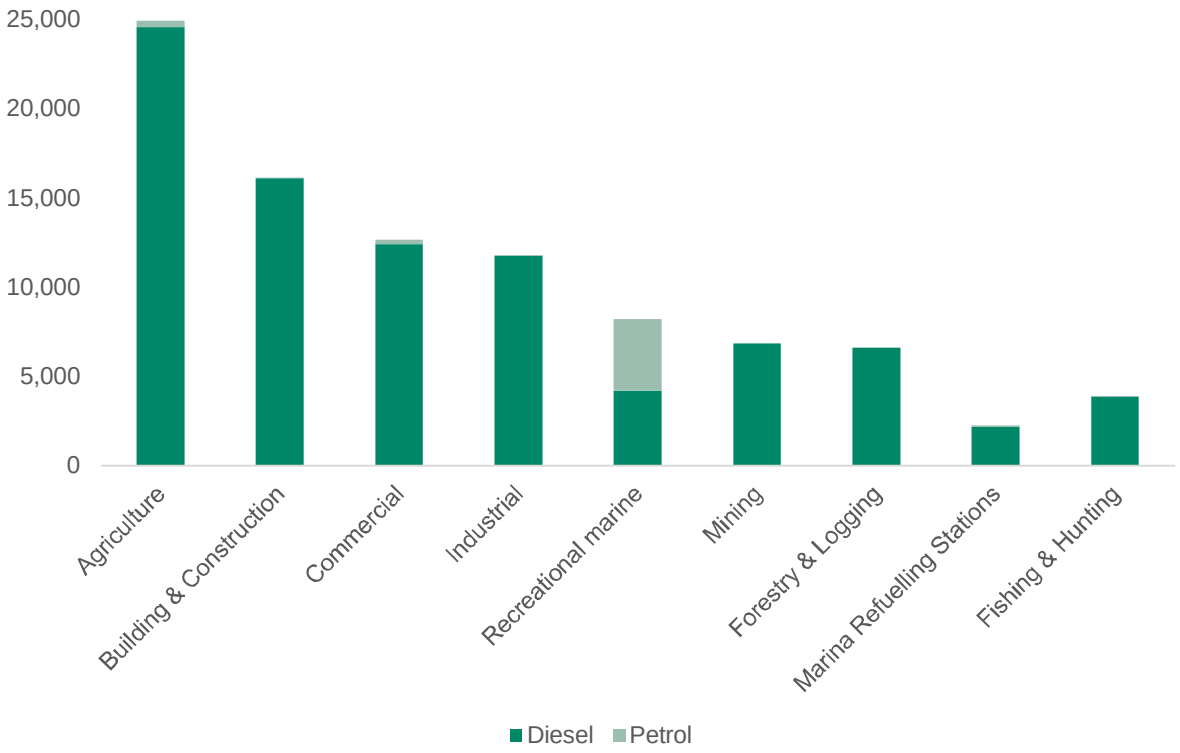

Figure 6 Off-road transport emissions by sector type and fuel type (tCO_2e)